



**PHARMACOGNOSTICAL AND BOTANICAL
IDENTIFICATION OF SOME IMPORTANT
BARK DRUGS USED IN INDIAN SYSTEM
OF MEDICINE**

ABSTRACT

Thesis Submitted for the Degree of
Doctor of Philosophy
IN
BOTANY

BY
RASHEED UDDIN AHMAD
Senior Scientific Officer
Pharmacopoeial Laboratory for Indian Medicine
GHAZIABAD

**DEPARTMENT OF BOTANY
ALIGARH MUSLIM UNIVERSITY
ALIGARH (INDIA)
December, 1989**

In Indian Systems of Medicine, various parts of the plant viz. root, stem, leaves, flowers, fruits, seeds, bark, modified structures, gums and the exudates etc., are utilised as important medicines, either singly or in combination, in a number of preparations alongwith mineral and animal origin drugs. Since these drugs are used in their own natural forms therefore, they are called 'Crude Drugs', while the drugs of Modern System of Medicine (Allopathy) are used in synthesised forms of the active chemical constituents.

These drug yielding plants are remembered with different vernacular names and even their common names, in different languages, also differ. Due to which the identification of the plants and the establishment of their authenticity of genuinness becomes difficult thereby resulting into substitution and adulteration with those of the genuine ones. To solve these problems tremendous work in the field of Pharmacognosy and Botany has been done in our country. But there are still a number of crude drugs which have not yet been evaluated scientifically i.e. Pharmacognostically and Botanically. Therefore, at present there is a great need to carry out research and standardisation work on these drugs, and solve the problems of authentication in order to lay down the Pharmacopoeial Standards of the drugs used in Indian Systems of Medicine (I.S.M.).

Keeping in view the above, in the present study three bark drugs viz. Maharukh or Araluka (Ailanthus excelsa), Kaiphal or Katphala (Myrica nagi) and Bakain (Melia azedarach) have been evaluated Pharmacognostically and Botanically to lay down the distinguishing characters for their exact identification and authentication. At present, there is no exact scientific data available on these drugs which could throw light on

their distinguishing characters, by which the drugs could be standardised. Even their detail phytochemical studies have not been made so far. In the present study, detailed macro-microscopical characters, botanical, and preliminary phytochemical investigation have been made. Attempts have been made to study the cell contents, microchemical and fluorescence characteristics of the stem bark of these drugs. These barks have also been subjected to preliminary phytochemical studies in order to determine the percentage of extractives, examination of different extracts for the presence of different chemical constituents, determination of ash contents, alcohol, and water soluble extractives etc. Thin layer chromatography and U.V. Spectrophotometric studies have also been performed on these drugs. The salient characters investigated for each drug are enumerated below:-

Distinguishing characters of stem and stem bark of
Araluka (*Ailanthus excelsa*)

Macroscopical characters

	Stem bark	
	Young	Mature
Size	0.3 - 0.5 cm. thick.	1 - 2 cm. thick.
Colour	Light yellow to grey externally.	Light grey to greyish black externally.
Surface	Slightly rough showing leaf scars and shallow longitudinal striations. Internal surface whitish grey to yellowish grey and smooth.	Rough due to deep longitudinal fissures and transverse striations. Internal surface light yellow to creamish yellow, rough and fibrous.

Fracture	Short in outer bark and splintery in inner bark.	Short in outer and splintery in inner bark and granular in transversely cut surface.
Taste	No characteristic odour and taste.	Odourless and bitter in taste.

Microscopical characters

Hairs	Uni to bicellular, uniseriate with slightly rounded to pointed tips with broad base.	—> Similar.
Primary structure	Endarch vascular bundles.	Endarch vascular bundles.
Phellogen	Originate in the epidermal cells.	Originate in the epidermal cells.
Cork	3 - 4 layered.	7 - 10 layered.
Stone cells	Present in singles or in groups of 2 - 4 or even more with narrow to wide lumen, rounded, oval to elliptical in shape, of varying sizes.	Present singly or mostly in groups of 2 - 8, larger in size with wide lumen, shape as in young stem.
Crystals	Few rosette crystals of calcium oxalate in cortical cells.	—> Similar.
Medullary rays	2 - 4 cells wide extending upto cortex, straight in xylem region and turned left or right in phloem region.	—> Similar.

Stem bark

	Young	Mature
Hairs	-	-
Primary structure	-	-
Phellogen	Originate in the outer most layer of the cortex.	—> Similar.
Cork	Wide zone of cork.	Strips of cork.
Stone cells	Present in singles, mostly groups of 2 - 4 in the secondary cortex, of varying size, shape and with wide lumen.	Present in between the cork strips as patches, in between the phloem fibres either singly or in groups of 2 - 3, few large in size with narrow lumen.
Crystals	Both prismatic and rosette crystals of calcium oxalate present.	—> Similar. Single rosette crystals of calcium oxalate present in each phloem parenchyma cell forming a crystal sheath of 3 - 12 crystal sheath of 3 - 12 crystals seen under T.L.S.
Medullary rays	1 - 4 cells wide, mostly straight.	1 - 9 cells wide, mostly 2 - 4 cells wide, straight.

Under ultra violet light the bark powder, when treated with 1N NaOH and mounted in nitro-cellulose, exhibits a light green fluorescence. The total and the acid insoluble ash of the bark are found to be 8.100% and 0.633% respectively. T.L.C. was also performed on the bark of Araluka. Under U.V. light the plate showed seven spots of different colours with Rf. values- 0.531, 0.593, 0.718, 0.750, 0.825, 0.906 and 0.960. The U.V. Spectrophotometric studies of the bark revealed the presence of two peaks, one broad at 284 n.m. and second relatively sharp at 324 n.m.

Distinguishing characters of thin and thick stem bark of
Katphala (*Myrica nagi*)

Macroscopical characters

	Stem bark	
	Thin	Thick
Size	0.2 - 0.5 cm. (light in weight).	0.5 - 2.0 cm. (heavy in weight).
Colour	Greyish brown.	Greyish brown.
Surface	Rough externally, having numerous whitish lenticels arranged transversely with longitudinal striations, smooth and reddish brown internally, channelled and quilled.	Rough externally, having longitudinal and transverse wrinkles with whitish scars of lichens, smooth and reddish brown internally, channelled.
Fracture	Short.	—> Similar.
Taste	Odourless and astringent.	—> Similar.

Microscopical characters

Hairs	-	-
Epidermis	-	-
Phellogen	Originate in the cortical cells.	Some of the deeper cortical cells show meristematic activity and form the outer bark and cork cells.
Stone cells	A number of stone cells present in cortical cells, in singles or in groups of 2 - 3, having different shape and size, even elliptical, having radiating canals, some with concentric striations and narrow to wide lumen.	A number of stone cells present in the cortical region, in the singles or in groups of 2 - 5, of varying size and shape, mostly elliptical, with narrow to wide lumen and radiating canals.
Starch grains	Simple and compound throughout the tissues, simple grains measuring 3 - 14 μ in diameter, compound consisting of 2 - 3 components.	—> Similar.
Crystals	Prismatic crystals of calcium oxalate present.	—> Similar.
	10 - 25 chambered crystal fibres present, each chamber having single prismatic crystals of calcium oxalate seen under T.L.S.	—> Similar
Medullary rays	Extended upto secondary cortex, 2 - 7 cells wide and 5 - 15 cells high.	—> Similar.

Under ultra violet light the bark powder, when treated with 1N NaOH and mounted in nitro-cellulose, shows bluish black fluorescence. The total ash and acid insoluble ash values of the bark have been found to be 1.700% and 0.166% respectively. T.L.C. plate when sprayed with anisaldehyde sulphuric acid reagent and heated at 110°C for 10 minutes showed spots of different colours with the Rf. values- 0.181, 0.521, 0.753, 0.804, 0.847, 0.898 and 0.949. The U.V. Spectrophotometric study revealed a single sharp peak at 294 n.m.

Distinguishing characters of mature stem bark of Bakain (*Melia azedarach*)

Macroscopical characters

	Mature bark
Size	0.2 - 1 cm.
Colour	Brownish to grey brown externally, brownish cream to yellowish internally.
Surface	Rough externally, fissures longitudinal, exfoliating and curved, internally slightly rough and fibrous, lenticels present.
Fracture	Short in outer bark and splintery in inner.
Taste	No odour and slightly bitter in taste.

Microscopical characters

	Young stem		Mature bark
	Early stage	Late stage	
Hairs	Uni-cellular → Similar. to branched (stellate), uni- cellular hairs broad at base and pointed or rounded at tips, branched hairs biseriate, multi- cellular stalked, and long radi- ating unicellular hairs with pointed tips.		-
Epidermis	Single layered → Similar. with thin cuticle.		-
Primary structure	Endarch vas- → Similar. cular bundles.		-
Phellogen	Originate in → Similar. the epidermal cell.		-
Cork	-	8 - 10 layered.	Alternating strips of many layered cork (inner and outer) due to the formation of Rhytidoma.
Crystals	Rosette → Similar. crystals of calcium oxalate present mostly in the cortex alongwith few secretory cells in the cortex and pith region.		Prismatic crystals of calcium oxalate mostly present in the secondary phloem region. Crystal fibres present, consisting of 15 - 25 prismatic crystals of calcium oxalate in each chamber.

Starch grains	-	-	Simple starch grains present throughout the tissue of the bark, mostly in the cortical and the secondary phloem region.
Medullary rays	-	-	3 - 7 cells wide, ending at the cork strips and get narrowed between two phloem fibre patches.

Under ultra violet light the bark powder, when treated with 1N NaOH and mounted in nitro-cellulose, exhibits a dark brown fluorescence. The total and the acid insoluble ash values of the bark are found to be 8.517% and 0.750% respectively. T.L.C. was also performed on the bark of Bakain. Under U.V. light the plate shows only two spots of blue colour with Rf. values- 0.341 and 0.780. The U.V. Spectrophotometric studies of the bark revealed two prominent peaks appearing in the U.V. region, one at 288 n.m. and the other at 318 n.m.

The drug has also been subjected to large scale extraction for isolation and characterisation of sterol with the help of column chromatography and by making the Infra Red and N.M.R. Spectrum studies. Sterol 'A' ($C_{27}H_{45}O$; m.p. $159^{\circ}C$) and Sterol 'B' ($C_{28}H_{44}O$; m.p. $135^{\circ}C$) have been isolated.



**PHARMACOGNOSTICAL AND BOTANICAL
IDENTIFICATION OF SOME IMPORTANT
BARK DRUGS USED IN INDIAN SYSTEM
OF MEDICINE**

Thesis Submitted for the Degree of
Doctor of Philosophy
IN
BOTANY

BY
RASHEED UDDIN AHMAD

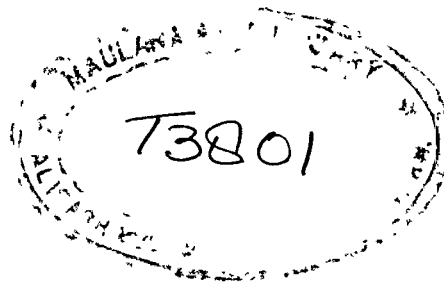
Senior Scientific Officer
Pharmacopoeial Laboratory for Indian Medicine
GHAZIABAD

**DEPARTMENT OF BOTANY
ALIGARH MUSLIM UNIVERSITY
ALIGARH (INDIA)**

December, 1989



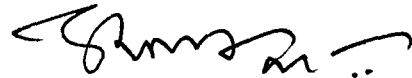
T3801



**TO MY PARENTS
&
WIFE**

DEPARTMENT OF BOTANY
ALIGARH MUSLIM UNIVERSITY
ALIGARH

This is to certify that the work described in this thesis
is the original work of the candidate done under my supervision.
The thesis is suitable for submission for the award of Ph.D.
degree in Botany.



(A.K.M. GHOUSE)
PROFESSOR OF BOTANY

C O N T E N T S

	Page
PREFACE	.... vi
ACKNOWLEDGEMENT	.... ix

CHAPTER - I

INTRODUCTION	.... 1
HISTORICAL RETROSPECT	.... 10

CHAPTER - II

PHARMACOGNOSTICAL AND PHYTOCHEMICAL STUDIES ON ARALUKA

A. ARALUKA (Ailanthus excelsa)

Introduction	.... 35
External morphology of the plant	.... 38
Pharmacognostical studies	.... 39 - 56
Materials and methods	.... 39
Macroscopical features:	
Young bark	.... 40
Mature bark	.... 40
Microscopical characters:	
Young stem	.... 41
Mature stem	.... 42
Young bark	.... 42
Mature bark	.... 43
Cell contents of stem and stem bark	.... 45

	Page
Microchemical tests	.... 47
Fluorescence analysis	.... 47
Phytochemical studies:	
Preliminary investigations	.... 48
Determination of percentage extraction	.... 48
Determination of Ash content and extractive values	.... 53
Thin layer chromatographic studies	.... 54
U.V. spectrophotometric studies	.... 56
Summary	.... 57

CHAPTER - III

PHARMACOGNOSTICAL AND PHYTOCHEMICAL STUDIES ON KATPHALA

B. KATPHALA (Myrica nagi)

Introduction	.... 60
External morphology of the plant	.... 64
Pharmacognostical studies	.... 65 - 80
Materials and methods	.... 65
Macroscopical features:	
Thin bark	.... 66
Thick bark	.... 66
Microscopical characters:	
Thin bark	.... 67
Thick bark	.... 69
Cell contents of the stem bark	.... 71

	Page
Microchemical tests	.... 72
Fluorescence analysis	.... 72
Phytochemical studies:	
Preliminary investigations	.... 73
Determination of percentage extraction	.... 73
Determination of ash content and extractive values	.... 78
Thin layer chromatographic studies	.... 79
U.V. spectrophotometric studies	.... 80
Summary	.... 81

CHAPTER - IV

PHARMACOGNOSTICAL AND PHYTOCHEMICAL STUDIES ON BAKAIN

C. BAKAIN (Melia azedarach)

Introduction	.... 84
External morphology of the plant	.... 88
Pharmacognostical studies	.... 89 - 104
Materials and methods	.... 89
Macroscopical features:	
Mature bark	.... 90
Microscopical characters:	
Young stem	.... 91
Mature stem	.... 92
Mature bark	.... 92

	Page
Cell contents of stem and stem bark	.... 95
Microchemical tests	.... 96
Fluorescence analysis	.... 96
Phytochemical studies:	
Preliminary investigations	.... 97
Determination of percentage extraction	.... 97
Determination of ash content and extractive values	.... 102
Thin layer chromatographic studies	.... 103
U.V. spectrophotometric studies	.... 104
Extraction of the drug for isolation and characterisation of sterols:	
Extraction	.... 105
Isolation	.... 105
Preparation of the column	.... 105
Developement of the column	.... 106
Elution of the column	.... 106
Characterisation of the isolated sterols:	
Preparation of derivative	.... 108
Comparative study of sterols 'A' and 'B' and their corresponding digitonide	.... 110
Tests for elements	.... 110
Estimation of elements	.... 111
Infra red spectrum studies	.... 111
N.M.R. spectrum studies	.... 113

	Page
Summary	.... 115

CHAPTER - V

DISCUSSION AND REFERENCES

A. Araluka	.... 118
B. Katphala	.... 124
C. Bakain	.... 130
References	.... 138

P R E F A C E

Since time immemorial India's rich medicinal flora has been utilised for curing different diseases. In the literature of Indian Systems of Medicine (Ayurveda and Unani), a number of these drug yielding plants are attributed with a number of medicinal virtues. These plants are used in their own natural forms as 'Crude Drugs', either as whole plant or their parts of, viz. Root, Stem, Leaf, Flower, Seed, Bark, Modified structures (Rhizome, Tuber and Bulb, etc.), and also as Gums and Exudates. Some of these drugs have scientifically been evaluated and clinically tried for their efficacy and properties, but still there are a number of drugs of plant origin, used in these systems, which are neither described in the literature nor their identity is properly established by the present day physicians of these systems, although they are used advantageously in the Indian Systems of Medicine. Due to the lack of knowledge and the scientific data available on the subject, a number of unauthentic samples of the drugs are sold in the market and employed in the preparation of medicines of these systems, leading either into adulteration or substitution even today. Further, it may be pointed out that as India is a vast Country and has different languages, a single drug is named differently or different drugs remembered with the same vernacular name, which causes a lot of difficulty and confusion in the exact identification of drugs e.g. three different botanical names viz. Cinnamomum cassia, Cinnamomum tamala and Zanthoxylum alatum are given for the drug used in Unani with the name Taj or Salikha. Similarly Eclipta alba, Jatropha curcas and Onosma echinoides are mistaken with

one another for Bhangra. Two different plant species Coptis teeta and Thalictrum foliolosum are mistaken for the drug Mamira. The drug 'Kali Moosli' is botanically identified with two different botanical names e.g. Curculigo orchioides and Aneilema nudiflorum. Like this many more examples may be cited where the exact botanical identification differ with each other for a single drug. Because of these difficulties not only adulteration or substitution takes place, but due to the ignorance or deliberate intention or even otherwise, on the part of drug dealers, problem of non-availability and exact identification of the drugs arise.

Since very little work has been done in respect of identification and standardisation of the drugs of Indian Systems of Medicine (ISM) in the country, specially on the Bark Drugs, it was therefore felt necessary to take up the study on bark drugs, so that the exact botanical identity could be established and pharmacognostical aspects could be worked out in order to provide exact data on the subject.

The present study deals with three bark drugs viz. Araluka, Bakain and Katphala. These three bark drugs are often adulterated or substituted with barks of other plants. Their vernacular names also differ and cause difficulty in identifying the genuine drugs, as Araluka in some literature is described as Mahanimba or Maharukha, while Bakain is also some times referred as Mahanimba in Ayurvedic and Unani literature as Maharukha. In case of Katphala, it may be mentioned that it has not been worked out so far in detail. It is because of these controversies these three Bark Drugs have been sorted out for the present study. Moreover, recently no botanical and pharmacognostical studies have been made which

could elucidate the exact identity of these drugs.

In present studies therefore, botanical, pharmacognostical and preliminary chemical characteristics of the three bark drugs have been under taken in order to elucidate clearly the salient diagnostic characters of the barks for identification purposes. Thin layer chromatographical (TLC) studies have also been undertaken for this purpose.

The subject matter of this thesis has been divided into five chapters given below:-


- CHAPTER - I has been devoted to the general introduction and historical background of the drugs investigated.
- CHAPTER - II has been devoted to elucidate the botanical, pharmacognostical and chemical aspects and the summary of the drug ARALUKA.
- CHAPTER - III has been devoted to elucidate the botanical, pharmacognostical and chemical aspects and the summary of the drug KATPHALA.
- CHAPTER - IV has been devoted to elucidate the botanical, pharmacognostical and chemical aspects and the summary of the drug BAKAIN.
- CHAPTER - V includes discussion, and the references of the drugs investigated.

A C K N O W L E D G E M E N T

I take this opportunity to express my sincere gratitude and thanks to Dr. A.K.M. Ghouse, Professor, Department of Botany, Aligarh Muslim University, Aligarh and Dr. M.S. Ansari, Director, Pharmacopoeial Laboratory for Indian Medicine (P.L.I.M.), Ghaziabad for suggesting me this problem for the Ph.D. work, and also for their constant supervision and guidance.

My thanks are also due to Shri K. Venugopal, Ex. Director (I.S.M.) and Vaidya S.K. Mishra, Advisor (Ayurveda), Ministry of Health and Family Welfare, New Delhi and Prof. A.N. Namjoshi, Chairman, Ayurvedic Pharmacopoeia Committee, (Government of India), Ministry of Health and Family Welfare, New Delhi for encouraging me to under take the present study. I am also thankful to my colleagues Shri N.S. Mahara, Shri B.B. Prasad, Shri Raj Pal and Shri Satyavir Singh in the Laboratory for their constant help and co-operation given during the course of the present study. I also wish to thank Shri Shaik Raheem of this Laboratory for the excellent typing, photography and drawing work.

Lastly, I feel great pleasure in thanking my wife Dr. Zeenat Rasheed, without whose encouragement, throughout the study, it would have not been possible for me to complete this work.


(RASHEED UDDIN AHMAD)

CHAPTER - I

I N T R O D U C T I O N

India has been provided with most varied kind of flora by nature, which is not found in any other part of the world. The extreme variability that India presents in its Geographical conditions, is perhaps unrivalled in the world. The tremendous range of variation in temperature from 49°C in desert areas in summer to -10°C in Dras in Kashmir in winters and the prevalence of arctic conditions throughout the year in some of the Himalayan ranges are well known. The annual rain fall varying from 1000 cm. at Cherrapunji in the Hills of Assam to less than 13 cm. annually in the desert areas of Rajasthan, the saturated air with moisture in coastal areas and the hills during South-West Monsoon and practically zero humidity during the dry weather period, are some of the interesting contrasts seen in this vast country. The lower hills, plateaus, extensively rich alluvial plains, sandy wastes and deserts, hills, streams, mighty rivers with their extensive deltaic and estuarine systems, numerous lakes and large marshy tracts provide all kinds of plants, yielding food grains, pulses, oil, rubber, tea, coffee, timber, spices and condiments, including drugs and many other commodities of economic importance like fruits, dry fruits etc. Our country infact is an epitome of almost all climates, seasons and soils of the world.

Under such a wide range of climatic conditions, it is natural to have a wide range of plants. Even the plants of tropical, sub-tropical, alpine and sub-alpine regions are met in one part or the other. It is difficult to find any other country of similar type, where such a variety of plants especially medicinal, are found growing wild.

Indian flora is closely related to that of Malaysia, Burma and China, which is abundantly represented in Eastern India. Alpine regions of the Himalayas represent Tibetan and Siberian flora, while Japanese flora is represented in the temperate belts of the country. The Middle Eastern, European and African floras are particularly met with in Western India. About 600 European genera are represented in India, many of them by single species. Moreover, some drug yielding plants introduced from America, Australia and European countries have got completely naturalised in this country. Therefore, all the factors mentioned above made the Indian flora very rich and cosmopolitan in nature. Prof. Greenish has very correctly said that "India owing to the remarkable variation, she possesses of climatic, altitude and soil, is in a position to produce successfully every variety of medicinal herb required by Europe." (29)

Out of a total of about 11000 species found in India more than 2000 plants are reported medicinal in the literature (30), and about 1500 of them are used in Indian Systems of Medicine (Ayurveda and Unani). They are attributed with a number of medicinal properties, uses and also remembered with different vernacular names in the respective systems of medicine. Though in the recent past a number of drugs have been worked out scientifically but still there are many important drugs commonly used in Indian System of Medicine yet to be evaluated on scientific parameters for their medicinal virtues. At present our country is not self sufficient in Pharmaceutical production, despite such an enormous potentiality in drug resources, and it is rather paradoxical that our country even today import drugs worth crores of rupees every year

to meet internal requirements (116). The reason for this sad state of affair may be many but one of the most important reason for this is the fact that the description of the drug yielding plants given in the literature of Indian Systems of Medicine is insufficient for the present day Pharmacognosist and Taxonomist to ascertain the correct identity of the particular drug of plant origin described in the classical texts of these systems, and also due to the fact that collection of the raw material (crude drugs) is mostly done by the unskilled, untrained and unqualified labourers in the field, which is then sold in the market to the drug dealers who themselves are uneducated and unqualified in this field. These drugs are ultimately sold to the manufacturers without providing the exact identification for each and every drug. This, not only leads into the adulteration of the drugs but also substitution with those of the genuine and authentic drugs used in the formulations of the Indian Systems of Medicine. As mentioned earlier the problems to be tackled are many and vary from the collection point of view to the standardisation of these drugs. The foremost and the important problems that are encountered in the exact identification and assessment in order to lay down the standards of the drugs, is the lack of knowledge about the source of the plant and insufficient identification data for botanical identity, alongwith the absence of the characters of these drugs by which one could differentiate them. In olden days the drugs used were less in number and the physicians used to collect the drugs and identify themselves. Moreover, the description available in the present day text books and literature on the drugs, is not sufficient for the exact

identification and also do not throw light whether the drug specimen is of the particular or genuine drug. Not only this, the vernacular names given to these drugs, in different regional languages in the classical texts, create still more confusion in the identification of the drugs. The regional names vary from place to place and one single drug is remembered with different names. As a result of this many of the plants mentioned in the classical texts have either totally been changed or unknowingly got mixed up with each other or have been replaced with other species, except in those cases where the botanical identity of the drug yielding plants have been confirmed, specially of those which are well known and well recognised. Thus, this has naturally led to an utter confusion. To add further to the confusion, the same name is frequently used for entirely different drug in different parts of the country. For example the drug 'Sariva' of Ayurveda (called Ushbah in Unani and Nannari in Tamil and Malyalam) which is botanically identified as Hemidesmus indicus in one part of the country, while in other parts it is identified as Ichnocarpus frutescence and Cryptolepis buchanani. Similarly two different plants viz. Marsdenia tenacissima and Ipomoea turpethum yield the drug 'Nishot' or 'Nishotar' of Ayurveda. The first, according to the recent literature, is the exact identification of the Unani drug 'Safed Turbud' (though the official drug Turpeth of I.P. & B.P. is nothing but Operculina turpethum Syn. I. turpethum). Like this many more examples can be quoted here which cause confusion and problem in the exact identification of the drugs.

Out of a large number of drugs described in the literature of ISM,

still many drugs have not yet been finally identified and are still considered to be doubtful and of controversial nature, though they are considered to be of significant importance because of their use and claims made for their wonderful cures. The description available on these drugs in the literature is so unauthentic and vague that it is not possible to ascertain their correct botanical identity, due to which, number of drugs currently being used in the market, are not genuine (either adulterated or substituted), obviously the practitioners and the manufacturers have to rely upon the material available in the drug markets, which is very often is so much either adulterated or substituted that it leads to the frustrations even to the experts in the field. Therefore, any amount of description of these drugs will not help a Botanist or Pharmacognosist to identify them and thus distinguish the genuine drug from the adulterated one, unless certain diagnostic characters of each drug is established, specially the actual botanical source of the plant and its macro and microscopical characters are made available.

Despite these short comings and difficulties, enumerated above, majority of the people of India use the drugs of Indian Systems of Medicine (Ayurvedic and Unani), as they are easily available and cheaper as compared to the drugs of Allopathic System of Medicine, specially in the remote rural areas, where the Allopathy does not have the excess. Not only this the drugs of ISM, these days are in much demand because of the side effects reported for the Allopathic drugs, not only in this country but also abroad. On the contrary they can often be easily

collected from roadsides, gardens, waste places and the fields. These above facts namely, easy and abundant availability, cheapness, efficacy and suitability to the temperament of the people of this country, bring into prominence, the importance of the indigenous drugs and their utility for the country.

Keeping in view the importance of the Indian Systems of Medicine and the increasing demand of the drugs used in these systems, the Government of India decided to develop these systems on the most modern scientific lines and revive these systems afresh, which during the British period had gone into total darkness under the shadow of the Allopathic System of Medicine. As a result, Government of India, in the Ministry of Health & Family Welfare (Department of Health), New Delhi have established a full-fledged department with the name "Indian System of Medicine (ISM)" to look into its overall development specially in the field of research, along with education and other allied aspects. To speed up the research work and to lay down the pharmacopoeial standards on these drugs the Ministry has established a Drug Standardisation and Testing Laboratory with the name P.L.I.M. (Pharmacopoeial Laboratory for Indian Medicine) at Ghaziabad. Along with this the Ministry of Health and Family Welfare, has also established separate research councils for Ayurveda, Unani, Siddha Systems and Homoeopathy at New Delhi as Headquarters. These councils carry out the research work on all the aspects of drugs used in Indian Systems of Medicines & Homoeopathy through their research units established throughout the country.

Recently the Ministry of Health has also established a Cell to look into the aspects of cultivation, collection regeneration, and also the aspects of import/export in respect of the medicinal plants, used in these systems as well as in the Allopathic medicine. Not only this the Ministry had long back constituted Pharmacopoeia Committees for the three respective systems (Ayurveda, Unani and Siddha), and also for Homoeopathy, for laying down the standards of the drugs of Indian Systems of Medicine and Homoeopathy in order to publish the Pharmacopoeia of the drugs used in these systems. Besides this, various other organisations in the country like the Central Drug Research Institute, Central Drug Laboratory, Haffkin Research Institute, and the Departments of Pharmacy and Chemistry in various Universities are doing a good deal of research work to solve these problems under the financial aid and grant provided by the University Grants Commission to the research workers interested in carrying out experimental investigation on indigenous drugs. Similarly, recently the Central Institute of Medicinal and Aromatic Plants (C.I.M.A.P.), and a number of Regional Research Laboratories (R.R.L.) under the Council for Scientific and Industrial Research (C.S.I.R.), and the National Bureau of Plant Genetic Resources (N.B.P.G.R.) under the Indian Council of Agricultural Research (I.C.A.R.), New Delhi are engaged in carrying out the research work on various aspects of medicinal plants, in-order to produce new varieties and strains for a better yield, and regenerate the plants which are threatened or at the verge of extinction, and also made available, the requisite information on any of the aspects concerning the indigenous drugs specially the medicinal plants.

However, the problems are tremendous and require a long range planning and devoted work by a large number of workers in a number of institutions. There is an increasing interest, not only in the country, but all over the world in scientific investigation of medicinal plants in the present century. Even the most advanced countries where numerous synthetic drugs and antibiotics have been developed, drugs from the plant sources are being tapped to find out better drugs and the interest of research workers appear now to be extending towards the natural products. It is therefore, realised that even if these studies do not yield more valuable drugs than synthetic ones, it will give valuable information about the chemical structures and pharmacological actions of the drugs, that may eventually open the door of creative synthesis of plant medicaments.

Basically the drugs of Indian Systems of Medicine are used either singly or in combinations (in the form of various formulations) and as mentioned earlier, these drugs are alleged by the physicians of Indian Systems of Medicine to possess medicinal properties. All these plants can not possess the wonderful virtues attributed to them, but it is belived that there are some of these, which might rightly deserve the reputation they have earned as curatives. In order to confirm the virtues attributed to them, a systematic study on these plants was initiated in early parts of the last century, since then many of these drugs have been proved effective by evaluating them on modern standards, and there are others, the claims of which have been found incorrect. There are still many drugs which have not been evaluated by any of the modern parameters and even their botanical identity is not yet confirmed but still

used in the Indian Systems of Medicine to cure various ailments.

Though a number of plants have been worked out for their chemical constituents but they have not been thoroughly screened for their pharmacological and clinical values. Therefore, at this juncture, there is a great need to take up this problem on a large scale for their exact botanical and pharmacognostical identification, chemical, pharmacological testing and clinical trials, in order to lay down the standards of the drugs used in I.S.M., and then only the real role of these drugs can be understood in combating different diseases, for which they are claimed.

HISTORICAL RETROSPECT

Voluminous and colossal historical records and immense reference are available on the use of plants, minerals and animals as source of medicaments for curing different types of ailments since time immemorial. These were written by the scholars and physicians of Indian, Chinese, Babylonian, Assyrian, Greek, Roman and Arabian civilisations on the basis of their experience and observations. This ultimately led to the development of various schools of medicines independently throughout the world viz., the Indian School of Medicine (4,500 B.C.), the Chinese School of Medicine (2,700 B.C.) in the east; the Egyptian School of Medicine (1,500 B.C.) including Babylonian-Assyrian School of Medicine (460 B.C.) in the west. The Indian School of Medicine gave birth to the present day Ayurvedic System of Medicine, while the Western School of Medicine (i.e. Egyptian, Greek, Roman etc.) to the so called Modern or Allopathic System of Medicine, and an off-shoot of the Greek School of Medicine emerged as an independent system of medicine called Greeco-Arabic System of Medicine or Unani Tibb in the Middle-Eastern countries, coming down to India with the Muslim culture, which ultimately flourished and developed as a full-fledged System of Medicine called Unani System of Medicine.

1. INDIAN SCHOOL OF MEDICINE (AYURVEDA)

The vedas are the earliest books of the Indian Mythology. These are Rigveda, Yajurveda, Samveda and Atharvaveda. According to Susruta, Ayurveda is an Upanga of Atharvaveda and was raised to the status of Veda and appended to it to give the science of medicine the necessary sanctity and authority. Ayurveda is the name, which the ancient Indian gave to their science of medicine (Ayu = life and Veda = to know or attain). There are two versions of its origin. The Medical School traces its origin to Bhardwaj who learned it from the God Indra, the Surgical School traces its origin to Dhanvantari who also received it from the same God. According to Charaka, Ayurveda emanated from the creator "BRAHMA" who revealed it in its entirety to Prajapati 'Lord of the Creators'. From him it was passed on to the Aswins "the divine twin horses" the helpers and the healers among Vedic Gods. They passed it on to Indra, King of God, and from him mankind received its divine wisdom. Other sources believed it to be derived from Rigveda compiled between 4,500 - 1,600 B.C. (104)

Whatever may be the origin of Ayurveda it is generally believed that the knowledge of the plants with many of their medicinal virtues was known to the ancient sages of India, which is generally traced to the time of Rigveda, in which many of the plants are mentioned as necessary in performing the religious ceremonies and mention has been made in this book of 'Soma' and 'Apamarga' and their effects on man. The other Vedas also mention the use of a large number of plants on similar occasions, particularly in Atharvaveda, where the medicinal use

of plants has definitely been stated, though their use often taken the form of charms, spells and incantation.

Charaka and Susruta are considered to be the great authority of this age (2,500 - 600 B.C.) in the field of Ayurvedic Medicine. Charaka (1,000 - 800 B.C.) deals more with medicine, while Susruta (800 - 700 B.C.) has dealt in great detail with Surgery. The simple medicines dealt alone by Charaka are grouped in Fortyfive heads (29). The methods of administration of drugs are fully described and bear a striking resemblance to those in use at present time. About 2000 vegetable remedies have been included by Charaka in his famous work called Charaka Samhita, but citing only few mineral and still fewer animal remedies. Charaka gives 50 groups of ten herbs each, while Susruta has arranged 760 herbs in 37 sets. From Charaka and Susruta various systems dealing with different branches of medicine originated. Surgery, Medicine, Materia Medica, and Pharmacy were divided into several systems (228).

In Ayurveda, beside the classical works of Charaka and Susruta, a number of books on Ayurveda and Botany were written. There are many important works called 'Nighantu' on Ayurvedic Materia Medica. The oldest Nighantu (Materia Medica) appears to be that of Deodas Kashiraj of Banaras (a King), who is also believed to be the incarnation of Lord Dhanvantari. He is believed to have taught his 'Dhanvantari Nighantu' to his disciples, amongst them Susruta was the most renowned. He is believed to have written another book called 'Raj Nighantu' on drugs, but some believe it to be written by another Vaidya named Dhanvantari, who lived during the time of king Vikramaditya.

There are about 400 drugs (herbs) described in this book, which has been giving inspiration to many authors later as the main source (104,206).

Ayurveda however, remained a subject of study which all learned men, sages and kings, learnt for the benefit of human race. The kings in particular encouraged the cultivation of medicinal plants specially trees, as may be testified from the fact that Ashoka the benevolent Emperor (274 - 236 B.C.), throughout his empire, established hospitals for men and animals and botanical gardens as source of medicines for the people. This was also the period of original research which resulted in remarkable progress in every respect. Mention may be made of some of the important works by Vagbhata, Madhvakar, Chakradatta, Kanada, Sankarsen and Bangasar (500 - 100 B.C.), who elaborated the vegetable Materia Medica and included many more new drugs of vegetable origin to the list of drugs of this period. The books on Botany like 'Kalpstanum' or 'Vrikshayurveda' described detailed characteristics of vegetable drugs, their geographical distribution, habit and habitat, suitability of soil for their growth, season of collection, duration of their efficacy, methods of storage and preservation, and elaborate classification with detailed instruction on every conceivable point.

Contribution of Sarangdhar (13th Century A.D) on Materia Medica, and Bhavamishra (16th Century A.D.), who has written a comprehensive treatise on medicine named 'Bhavaprakash Nighantu', describing more than 600 drugs, including some drugs of other systems, are worth mentioning. In Saligram Nighantu (18th Century A.D.), 1574 drugs with

some illustrations giving their synonyms in other languages have been described (185,206).

2. CHINESE SCHOOL OF MEDICINE

Origin of the Chinese Medicine is attributed to the mythical God believed to have flourished about 2,735 B.C. (206). The Chinese Medicine has a Pharmacopoeia like compilation in Chinese called 'Pun Tsao' or the 'Great Herbal', having 40 volumes describing several thousand preparations. Chinese were the earliest to employ Goose grease the 'adepts amberinus' of the later Pharmacopoeiae as a preferable fat for inunction, and the modern scientific researches on the penetrating properties of fat places it on top. The other medicines employed by the Chinese from various origin (plant, mineral and animal) are described below:-

Sea Weed as Iodine source, Rhubarb, Aconites, Cannabis, Ephedra (Ephedrine source), Camphor, Iron, Sulphur, Mercury, Alum, Musk, Toad's Eye-lids and Earthworms.

3. EGYPTIAN SCHOOL OF MEDICINE

In the West, before the advent of Greek Medicine, records of drugs usage are also available in the form of Egyptian Materia Medica, Assyrian and Babylonian Pharmacy. The famous "Ebers Papyrus", believed to be written about 1,500 B.C. contains a collection of prescriptions and formulae with a wide range of uses (206,222-224).

The following drugs of plant, mineral and animal origin are described in the Egyptian Materia Medica (Ebers Papyrus). They are:-

Oil, Wine, Beer, Yeast, Vinegar, Turpentine, Figs, Castor Oil, Myrrh, Mastich, Frankincense, Worm Wood, Aloes, Opium, Cumin, Peppermint, Anise, Fennel, Saffron, Lotus flowers, Linseed, Juniper berries, Henbane, Poppy, Mandragora, Gentian, Colchicum, Squill, Cedar, Elder berries, Honey, Grapes, Onion, Garlic, Acacia, Date Blossoms, Iron, Lead, Bitumen, Magnesia, Nitre, Vermilion, Copper Sulphate, White Lead, Crude Sodium Carbonate, Salt, Precious Stone (in finely powdered 'Calcined' forms), Lizzard's Blood, Swine's Teeth, Putrid Meat, Stinking Fat, Moisture from Pig's Ears, Milk, Goose Grease, Ass's Hoofs, Animal Fats (From various sources), Excreta of various animals (including Human beings, Donkey's, Antelopes, Dogs and Cats and even Flies).

In the library of Sardana-Palus at Ashurbanipal (650 B.C.) clay tablets have been found belonging to Assyrian and Babylonians, relating to medical and pharmaceutical subjects. Their list of drugs resembles that of Egyptian Materia Medica, where 250 herbs, and 120 minerals and stones are described, among which are Cassia, Cinnamon, Costus, Orris Root, Anise, Jasmine, Oleander, Allamander, Cathartica, Mint, Henbane, Liquorice, Alcohol, Turpentine and Beer of plant origin, while of animal and mineral origin are Fats, Oils, Wax, Bitumen and Alum etc., respectively.

4. GREEK SCHOOL OF MEDICINE

Greek medicines' origin is traced back to Aesculapius, who was probably a historical personage and subsequently deified by the Egyptian and other ancient people. Actually in the West the history of medicine

and pharmacy begins from Hippocrates, who[^] born in the Island of Cos^{was} in 460 B.C. and is considered to be the father of medicine and said to be a descendent of Aesculapius. In his writing, Hippocrates has mentioned nearly 400[^] simples as medicinal substances. Theophrastus (370 - 287 B.C.), later on who received the herb garden of Aristotle, mentioned in "On the Causes of Plants" 500 drugs. However, the most authoritative and significant Pharmacopoeial treatise of the Greeks' was the text of Dioscorides (60 A.D.). He is said to become Surgeon in Neuro's army to learn the flora and fauna of different countries. During his army career, he collected a vast number of drug samples of plant, animal and mineral origin and confirmed their identity and mineral virtues whenever he got the opportunity. His famous treatise on Materia Medica was first published in Venice (Greece) in 1499 and for 1600 years it served as Pharmacological Vadmecum in the history of medicine. This book was translated into Arabic and other European languages and is very often quoted in the works of Arab authors. This treatise was arranged in alphabetical order and described the drugs of different origin (plant, mineral and animal) (206). These are:-

Acacia, Aconite, Aloes, Anise, Balsam, Bitter Almond, Buck Thorn (Rhamnus), Cardamom, Cumin, Dill, Elaterium (Juice of the Cucumber fruit), Gentian, Hemlock, Juniper, Lettuce Vinegar (Vinegar of Lactuca), Lichens, Licorice (Liquorice), Mandrake (Mandragora), Mint (Mentha), Penny Royal (Penny Wort), Poppy, Rose Oil, Worm Wood, Ammoniac, Arsenic, Bitumen, Bird Lime, Brine (Salt), Calamine, Caustic Lye, Soot, Verdigris (basic Copper acetate), White Lead, a number of metallic oxides, sulphates

and sulphides, Ash of Hippocampus, Canthrides, Fish glue, Urine, and few others are Boiled Oil, Starch and Wine.

Amongst other Greek Workers the names of Pliny the elder (23 - 79 A.D.) and Galen (130 A.D.) are worth mentioning. Pliny a contemporary of Dioscorides on "Natural History" wrote 37 books, out of which 20 - 27 deal with medical botany (medicines derived from plants), 28 - 33 deal with Materia Medica i.e. other than botany (drugs derived from the bodies of men and other land animals). Similarly Galen, who is believed to have died in Sicily and born at Pergamum, had kept a pharmacy for a long time and is believed to have developed a number of medicinal preparations of plant origin called "Galenicals". On Pharmacology Galen is credited with 30 books. In one of the books (translated into Latin under the title "De Cimplicibus"), items have been arranged in alphabetical orders and enjoyed great repute. His other works were translated into Arabic. He also became the Physician to Comodus and during his travel devoted a great deal of his time in collecting the choicest drugs to have at his disposal. In his writings he always emphasised on the importance of the pure drugs and careful handling of them and advised to the readers "in order to know the drugs, inspect them not once or twice but frequently for though twins look alike to strangers, they are easily distinguished by friends".

5. ARAB SCHOOL OF MEDICINE

After the decline of medicine in Rome and the texts of earlier Greek workers were forsaken, Galen gradually assumed highest authority in medicine and luckily the Greek medicine found its votaries

in Arabs, who translated as much work into Arabic as they could found. Great contributions have been made by the Arab physicians on the medicinal properties of the plants, though their publications are based on the Materia Medica of Dioscorides and Galen etc., but with lots of new additions alongwith the foot notes and commentaries. There is abundance of references of the book "Almaliki" of Ali-ibn-Abbas, and for the development of the Arab medicine as a whole, the names and the contributions of luminaries like Qusta-bin-Lauqa, Hajjaj-bin-Mutar, Ibn-ul-Batriq, Isa-bin-Yahya, Ahmad-bin-abi-al-Ashat, Ibn-i-Jaljal (Galgall), Abu Sahal Masihi, Abi-ibn-Saadiq, Abul Hasan Qarshi, Ali-bin-Rizwan, Ibn-i-Wafid, Hakim Raziuddin Abul Mansoor Saeed bin-Bushar-bin-Abdus, Jarji-Zidan, Abdul Qasim Halaf ibn-al-Abbas al-Zahrawi "Avenzoar", Yuhanna-bin-Masawayh (777 - 857 A.D.), Abul Hasan al-Tabari (9th Century), Yaqub bin-Ishaq al-Kindi (800 - 870 A.D.), Abu Bakr Mohammad bin-Zakaria Razi "Rhazes" (854 - 932 A.D.), Shaikh Bu Ali Seena "Avicenna" (980 - 1037 A.D.), Abdullah Mohammad Al-Idrisi "Sharif" (1100 - 1166 A.D.), Ziauddin Abu Mohammad Abdullah ibn-e-Ahmad al-Maliki "Ibn-al-Baitar" (1197 - 1248 A.D.) and Ibn-an Nafis (1210 - 1288 A.D.) are worth mentioning. (163,10)

Besides all the physicians and workers already mentioned in the preceding paras one should not ignore the names of workers who wrote valuable treatise on Materia Medica like Yahya-bin-Jazla "Mughni". Abu Rehan al-Biruni, Haji Zain Uddin Attar, Shaikh Yusuf of Baghdad. (163,10)

Zakaria Razi "Rhazes" is credited with having written 250 works. Some of which are on Pharmaceutical aspects. Rhazes, amongst his

contemporaries, was known as Galen of his time. His most famous contribution is "Al-Hawi-Kabir" or "Continents of Rhazes". Garison in his "History of Medicine" classes Rhazes with Hippocrates in his influence upon medicine.

Avicenna amongst the Unani physicians was known simply as Shaikh. He is the world renowned author of the book Canon (Al-Qanun). In fact, he was the founder of Greco-Arab School of Medicine. During the middle ages the Canon of Avicenna was by far the most popular text book of medicine in Europe and was most frequently quoted by later writers. Actually Avicenna's work was considered authoritative and used by the Universities of Europe till as late as 1650. It is his likeness that adorns the diploma of Pharmaceutical Society of Great Britain. His second volume of Canon described 719 drugs.

Al-Idrisi was born in Sevta and educated in Spain. He is famous for the collection of herbs. Alongwith him the name of Rasheed-uddin-Suri, who toured the hills and forests of his country Syria is associated in search of medicinal plants. The reference of his work is found in the famous book 'Al-Aqaqir' * (believed to be written by Ibn-al-Baitar), where 1400 drugs are described, and references of more than 150 Arab and Syrian Physicians, who were concerned with the collection of the information about these

* According to Leclerc the name 'Sharif' refers to Abdullah Mohammed Al-Idrisi. Previously, the exact period, in which he wrote the Materia Medica, was not known. It is only recently that Prof. Helmut Ritter has announced the presence of the book "Al-Aqaqir" while he was searching the manuscripts on this topic in mosques and libraries of Constantinople, as like the lost book of Al-Idrisi. Later on Dr. Max Mayerhof has published his paper where he has confirmed that this book is the same by Al-Idrisi, which was deemed lost. The manuscript of Al-Aqaqir is kept in the library of History of Medicine, Istanbul, on which no date is written. Previously it was believed that 'Al-Aqaqir' was written by Ibn-al-Baitar.

drugs are mentioned. Out of these 150 Physicians, the name of Al-Idrisi has been referred as 'Sharif' more than 200 times and is believed to be an authority of drugs of plant and animal origin of North Africa.

Ibn-al-Baitar was the Chief Botanist in court of Egypt. He travelled through North Africa, Spain, Greece, Italy, Syria and Asia Minor. He visited the botanist of every country and the herbs in their natural growth and investigated their properties experimentally. In his monumental work "Jame-ul-Mufredat"^{**} collected the remarks of Dioscorides, Galen, Rhazes, Avicenna and others on drugs. It deals with 2,000 drugs out of which 1,700 are of plants alone. Another book written by him on Materia Medica is known as 'Kitab-ul-Mughni-fi-al-Adwiya-al-Mufarreda'.

Shaikh Dawood of Antakia wrote a book (about 1008 A.H.) on medicine named 'Tadhkirat-ul-Albab', better known as "Tadhkira Dawood Antaki", describes several hundred herbs, besides animal and mineral origin drugs.

Abul Farj-ibn-al-Qaf (630 - 685 A.H.), the pupil of Hakim ibn-i-abi-Usaibiya (the famous author of 'Tabqat-ul-Atibba' and was given the title of 'Ameen-ud-Daula' in the royal court of physician), is the author of several books on medicine besides a commentary on Canon (Al-Qunun) of Avicenna in six volumes. His book 'Kitab-ul-Umda-fi-al-Jirahat' contains 20 sections of which section 11 gives the description of 212 drugs, dealing with surgical practices, and section 20 deals with Salves, Ointments and Oils, used for dressing wounds.

Yusuf-bin-Omar 'Sahab-ul-Yemen' (died 694 A.H.), the author of

^{**} An Egyptian edition of the book is available. Part of the work were published at various times in Latin under the name of 'Simplica'. A French translation by Leclerc is also available as 'Notices at extraits des manuscrits dela Bibliotheque Nationale'.

'Almotamad' printed in Egypt, has described only frequently used drugs with their actions.

Arab's contribution may also be recognised by going through the records on the translation work done on Indian and Persian books into Arabic. This aspect of study highlights the fact that how the drugs of different origins (Greek, Persian, Indian etc.) got mixed up and were included in their medicaments and the Materia Medica through ages. Yuhanna-bin-Masawayh in his book 'Jame-ul-Tibb', wrote that a number of books of Sanskrit were translated into Arabic. The authors whose work was translated are Kinkar, Manjal, Bakhar, Saleh-bin-Bahilla etc. The important books translated are 'Israr-ul-Mawalid', 'Kitab-ul-Adwa', 'Kitab Shark-ul-Hindi', Kitab-ul-Somum, Kitab Sasru-fi-Tibb-Asma Aqaqir-al-Hind, 'Astankar-ul-Jame', 'Mukhtasar-ul-Hind-fi-al-Aqaqir', 'Ilajat-ul-Atibba al-Hind al-Tauhum-fi-al-Amraz-ul-Alal', 'Rae-al-Hind-fi-al-Hayat-o-Samumha' and Shanaq Hindi etc. (222-224).

6. GRECO-ARAB SYSTEM OF MEDICINE (UNANI)

The system which originated in Greece and developed by Arabs into an elaborate medical science, on the basis of the teaching of Hippocrates, Dioscorides and Galen, is called Greco-Arab System of Medicine, which later on, after centuries, came down to India with Muslims advent, and flourished with the name Unani System of Medicine. It has imbibed the best what was known to other contemporary systems of medicines in Egypt, Syria, Iraq, Persia, India, China and other Middle and far Eastern Countries, as already mentioned.

Amongst the Indian Physicians the names of Hakim Syed Mohammad Hussain, Hakim Raza Ali Khan of Deccan, Hakim Mohammad Azam Khan, Hakim Mohammad Najmul Ghani Khan are very important to be mentioned. Similarly Hakim Ali Gilani, Hakim Momin and lastly the name of Hakim Shareef Khan may also be included as important contributors. Hakim Syed Mohammad Hussain, who wrote 'Makhzan-ul-Adviya' is the pioneer worker among the Unani Tabibs (Physicians) in India. His original work is in Persian language which has been translated into Urdu also. It describes nearly 1,500 drugs including hundreds of herbs growing in India. It also describes Cinchona bark and Quinine. Hakim Raza Ali Khan of Deccan is the author of "Tadhkirat-ul-Hind", in Persian language, on Indian herbs. He mentioned the Sanskrit and South Indian names of some herbs on the basis of his own experience and observation. Hakim Mohammad Azam Khan (died in 1902) is the author of the masterpiece "Muheet-i-Azam" in four volumes, describing several thousand drugs, including some used in Allopathic medicine. Hakim Mohammad Ghani Khan (son of Hakim Azam Khan's sister), wrote a voluminous book "Khazanat-ul-Adviya" in 1915. It is on the line of "Muheet-i-Azam" and is in Urdu, which includes more Allopathic medicine, describing 2,612 drugs.

INDIAN SCHOOL OF MEDICINE **AND ITS IMPACT ON FOREIGN COUNTRIES**

The Indian medicine made enormous progress after the time of Charak and Susrut, which achieved its highest peak of development upto 1200 A.D., and made its way to the far off countries like Egypt, Greece and Rome. The reference of many Indian plants especially of the aromatic group are mentioned by Dioscorides in his work. Mention of the 'Cinnamon Oil'

exported from India has been made by Ktesias of Knidos, who was a Physician to Artaxerxes Mnemon (about 400 B.C.) (188). Similarly the anonymous author of Periplus, states that Costus (Saussurea lappa) was exported from Sind. Pliny in his book also refers about the import of costly Indian drugs against the heavy drain of Roman Gold (*Historia Naturalis*, Vol. XXIV, P.1).

A mention has earlier been made that the exchange of knowledge took place during the Arab School of Medicine, by way of translation of Indian and Persian books into Arabic. Accordingly the great works of Charak and Susrut were translated into Arabic during Abbasid period (8-9th Century A.D.). These translations in turn, alongwith the original works of Arabic medicine, were translated into Latin, and later these formed the basis of European medicine, which were taught to the students in Europe till 17th Century. Alongwith this a number of work on Indian medicine and native medicien were translated into Arabic (Dietz, "Analecta medica", Wustenfled, "Geschichte der Arabischem Aerzte" (1840), Fluegel and Others). Reference of many Indian drugs like Pepper, Lac, Nard, Liquorice (Glycyrrhiza), Asafoetida, Ocimum, Bdellium, Cinnamon, Myrrh, Red Sandal, Calamus (*Acorus calamus*) and Chebulic Myrobalan are available in the *Materia Medica* of Arabs, indicating the exchange of knowledge, and came into use in their medicaments (162).

INDIAN MEDICINE AND ITS POSITION DURING MEDIEVAL INDIA

There were many causes of the decline of Indian Medicine during the Medieval period. Firstly the import of the Buddhist doctrine of Ahimsa (Non-killing), led people to consider touching and dissecting of dead bodies

as a sin, which resulted in the decline of Surgery, though medicine maintained its progress, during the Buddhist period and a large number of drugs of plant origin were added to the already extensive list of the Materia Medica of Indian medicine. Secondly due to the successive invasions of India by Greeks, Scythians, Huns and the Muslims, a good deal of the existing literature of Ayurveda, either got lost or mutilated. After setting on the Muslim rule in India (thirteen century onwards), the Greco-Arabic or so called Unani Tibb, became the state system of medicine, which slowly resulted in throwing the Indian System of Medicine into the background. The Arabic System brought with a rich store of its own Materia Medica, which was unknown to India, during the long period of Muslim rule (specially the Medieval period), this system in close contact with the Ayurvedic System of Medicine resulted into a great deal of intermingling and simultaneously progressed.

INDIGENOUS SYSTEMS OF MEDICINE (AYURVEDA AND UNANI TIBB) **THEIR DECLINE AND EVOLUTION.**

Advent of Europeans in India, firstly the portugese, then the French and lastly the British, made a great loss to the Indian System of Medicine. Both the system i.e. Ayurveda and Unani declined gradually after the fall of the Mughal Empire, when the British rule was established and the European System of Medicine (Allopathy) was introduced into India. As a result the Indian Systems of Medicine were further thrown into the background. However, both these systems were practiced in India and served as the main source of medical relief to the majority of the Indian population, especially to those who were poor, as the medicines of Indian System of Medicine were cheaper as compared to the Allopathic System.

Though the Indian System of Medicine were thrown in the background, but the potentialities and curative properties of the indigenous drugs (especially those of the Indian Medicinal plants) were however, realised even by the British, and since then many workers and scientists have attempted to identify the botanical source and explore many more new drugs with the help of local Vaidyas, Hakims, Pansaris and local people. In this direction the work of Sir William Jones (82), "Botanical observation on selected Indian Plants" was one of the foremost contribution to be recognised. This was followed by many other workers like John Fleming's (60) "Catalogue of Medicinal Plants", Ainslie's (1) "Materia Medica of the Hindustan", Roxburgh's (170) "Flora Indica", and Wight's (227) "Icones Plantarum Indiae Orientalis" and later the works of Wallich (207), Royle (171), Strachey (198), Boissier (22), Kurz (103), Hooker (72) and Duthie (54) etc., can be cited as important works in resolving the problem of identification of the drugs used in these system which added to the knowledge for the later workers. Of the earlier workers on Materia Medica and Pharmacology of Indian Medicinal Plants, the names of O'Saughnessy (124), who has written 'Bengal Pharmacopoeia', for the first time described scientifically the properties and use of drug plants of Bengal. This was followed by Irvine's (73) 'Materia Medica of Patna'. 'Pharmacopoeia of India' by Dr. Waring (221), Dutt's (55) 'Materia Medica of the Hindus' and Dymocks (56) 'Vegetable Materia Medica of Western India' are worth mentioning. However, the two most important and comprehensive works namely 'Pharmacographia Indica' of Dymock, Warden and Hooper (57) and 'Dictionary of Economic Products of India' by Sir George Watt (225,226) stayed as most outstanding and by far the most valuable of all the previous

works and remained even today, with few exceptions, an important source of scientific references for the present day workers. These works were followed by 'Indigenous Drugs of India' by Kanni Lal Day (53), 'Indian Medicinal Plants' by Kirtikar and Basu (93), 'Pharmacopoeia Indica' by Bose (23) and lastly 'Indigenous Drugs of India' by Chopra (29). In this regard some of the important publications of Council for Scientific and Industrial Research (CSIR), Govt. of India, in the field are 'The Wealth of India' (200), which gives the list of available literature on most of the medicinal plants; 'Glossary of Indian Medicinal Plants' (31-34), which is a catalogue, giving the references to important investigations on medicinal plants, with their uses, sources and the individual parts used for different diseases. More or less complete bibliography of published papers on Indian Medicinal Plants, with the name 'Review of work on Indian Medicinal Plants, has been published under the patronage of Indian Council of Medical Research (ICRM), by Chopra and Chopra (30). Recently the Indian Council of Agricultural Research (ICAR), has under taken to publish a review of recent work on phytochemistry of medicinal and allied plants (39), Chopra et. al. (36) in "Chopra's Indigenous Drugs of India" give the most upto date information about almost all the important medicinal plants used in Indian System of Medicine in the country, and Chopra et. al. (38) have also published the book entitled 'Poisonous Plants of India' where the habitat, morphology, chemistry and pharmacology of the important poisonous plants have been enlisted. Chopra et. al. (37), alongwith these books, have also published the list of 'Insecticidal and Pesticidal Plants of India'. A brochure on 'Medicinal Plants of Arid Zones'

has been edited by Chopra et. al. (28), and has been published by UNESCO.

In spite of the above mentioned work, very little has been explored on the chemical, pharmacological, and pharmacognostical aspects of Indian Medicinal Plants till recently, with the exception of some workers, from time to time, who have taken up investigations on some of these drugs. Keeping in view the vastness of the problem, a lot has yet to be done, especially in the field of pharmacognosy, which was least attended to as compared to chemistry and pharmacology.

STATUS OF PHARMACOGNOSTICAL STUDIES DURING ANCIENT AND MODERN PERIODS IN INDIA

Though, much of references on the exact beginning of the pharmacognostical studies is not available during the ancient period however, reference can be made of 'Kallpastanum' or 'Vrikshayurveda', where along with many of the botanical topics, aspects like geographical distribution, soil, habitat, seasons of collecting of medicinal plants, duration of their efficacy and methods of storage etc., have been described. Not only this even the drugs and medicinal plants have been classified under different heads, which have further been divided into different groups such as bulbous and tuberous roots, root barks, barks of trees having peculiar smell, leaves, flowers, fruits and seeds, acrid and astringent vegetable products, milky plants (with latex), and those having gums and resins. Special instructions have been given for the proper time of collection of different drugs, parts to be collected, methods of preparation of drugs along with weights and measures to be used, while dispensing them. Mention has also been made on the cultivation practices of the drug plants

during that period. However, the book "Handbuch der Pharmacognosie, Vol.I, Part II, PP. 499-510" by Tschireh, throws the light in detail on the pharmacognostical history of India. Reference may also be made in this regard to "Pharmacographia" by Flueckiger and Henbury (61), and to several other books on pharmacognosy.

As it has already been mentioned earlier that much of the works, due to foreign invasions became mutilated or lost, therefore, records of the works done on the subject, during this period is not known. However, during the end of the last century and beginning of the present century i.e. within few decades some British and few workers of this sub-continent initiated research work on drugs as enumerated above, and many of them have made careful studies on the micro and macroscopical aspects of a number of medicinal plants, especially those which were included in the Indian and Colonial Addendum of 1900 and the contribution of luminaries like Forsdike (62-64), Greenish (66-70), Melville (111-113), Trease (202-204), Wallis (208-220), Youngken Sr. and Jr. (229-247) and others (40,71,77,78,164,186,191-193) are worth mentioning.

On this basis, a number of research workers have also initiated studies recently in India on the Pharmacognostical aspects of Indian Medicinal Plants. Few important names of research workers in this regard are - Bal (11,12), Bal and Datta (13), Krishnaswamy and David (97), Datta (41), Datta and Bal (42-44), Datta and Mukerji (46-48), Datta et. al. (43,45, 48,49), Mehra and his associates (105-109), Bhatnagar (17-21), Sircar (189,190), Quazilbash (157-160), Shah et. al. (175-183), Nayar et. al. (120-123), Rohatgi (165,166), Santra (173), Mittal (114,115), Atal and his associates (2-7), Prasad (125-131,133,136-139), Iyer (75), Prasad and his

associates (140-156), Chaterji and Lahiri (26) and a few others (14,65, 86-88,189). It may be noted that most of the pharmacognostical work has been done on microscopical aspect and only few workers have concentrated on cultivation studies (27,90,82,132,134,135). It may also be noted that inspite of the fact that in modern pharmacognosy, many workers in the west, have turned towards chemical and biochemical aspects (161,242-247), but macro and microscopical studies still remains the predominant aspect of study of medicinal plants, though in recent times it further shifted to the study of natural products (main chemical constituents of the active ingredients), which however, does not serve the purpose as the problem of adulteration and substitution is not solved only by the biochemical or natural products studies, as the drugs used in Indian Systems of Medicine are yet to be identified for their, distinguishing characters for identification and standardisation purposes.

Therefore, particularly in India, at present there is a great need to take up the anatomical studies on most of the indigenous drugs, where this work has not been taken on a large scale. To tackle this problem a thorough knowledge of the macro and microscopical characteristics of crude drugs is of utmost importance, especially when adulterant drugs happen to resemble with the genuine drugs in its external form and appearance as in the case of many root and bark drugs, or if the drugs are shrunken, crumpled, or otherwise changed by drying or preparation, or if the drugs happened to be in crushed or powdered form, it is by no means easy to ensure the authenticity of the sample. But when the genuine and adulterated drugs are untire forms or even in somewhat broken conditions, and are dissimilar in external morphology, they can be quite

easily identified because they show clearly recognised gross characters associated with the drugs in question.

ROLE OF PHARMACOGNOSY IN THE IDENTIFICATION OF DRUGS WITH THEIR ADULTERANTS AND SUBSTITUTES

As we all know, the plant body as a whole is made of cells and in-turn tissues, giving rise to the various parts of the plant body. It is also a known fact that each part of the plant body is composed of dissimilar cells of differentiating characters. Most of the drugs (genuine) and adulterants have their own macro and microscopical structures, by which they can definitely be recognised. Hence, the macro and microscopical examination in such cases, whether whole or in powdered form, help in recognising the genuine drug with those of adulterants or substitutes. Moreover, anatomical study of any of the parts of the plant viz. leaves, stems, roots or any other part, reveals that there are basic structural patterns found in different plants thereby giving rise to different diagnostic characters, which ultimately help in their identification.

A number of adulterant drugs, due to their external resemblance, are sold in the market in place of the genuine drugs. These drugs can easily be distinguished by studying their external and internal characters e.g. shape, size and number of per unit area of epidermal cells, the stomata, the trichomes and also by examining in detail their anatomical characters such as presence or absence of crystals of calcium oxalate, their form and location. Even these characters when present, help in identifying not only the genus but also the species of the plant (51,52, 59,167-169,196). Some of the examples of the drugs sold in the market

as adulterants or substitutes are - Henbane leaves, marketed as Dandelion leaves because of their resemblance. Ailanthus leaves have been substituted or mixed with those of Belladonna, Spearmint, or Senna (212) and Vasaka (174). Their exact identity can be confirmed by cutting transverse section of the midrib, and difference in their structure gives definite clue to their identity. Here it will be worth to point out some important examples as to how the pharmacognosists have employed differences in macro and microscopical features in distinguishing allied species or one drug closely resembling with the other drug. The Buchu leaves (*Barosma* species) have been differentiated, besides the quantitative factors, such as vein-islet numbers, palisade ratio and stomatal measurements, by the variation in radial and outer walls of the cells of epidermis, size of trichomes on laminae and petioles, and also dimensions of calcium oxalate crystals. Spanish or Portugues Digitalis (*Digitalis thapsi*) is closely similar to *Digitalis purpurea* but it is easily differentiated by its trichomes, which are glandular, usually uniseriate, with unicellular, spherical glandular head (51). Similarly Digitalis leaves can be differentiated with their adulterants like Mullelin leaves (*Verbascum thapsus*) which are covered with large, branched wiry hairs, and with the adulterant Primrose leaves (*Primula vulgaris*) and Comfrey leaves (*Symphytum officinale*), and other adulterants by shape, margin, venation and nature of trichomes (184). Seeds of various species of *Strophanthus* e.g. *Strophanthus kombe*, *S. gratus* and *S. sarmentosus* have also been differentiated on the basis of various pharmacognostical parameters (184). Not only this, the stem drugs can also be differentiated by studying nature of cell walls, occurrence of leaves and trichomes, presence or absence of pith and nature of its cells, position

and nature of xylem elements, nature of cortical and other tissues of the drug, medullary rays, its width and height, presence or absence of particular types of sclerenchyma and its elements and even the cell contents. The Indian hemp is differentiated with Lobelia by the presence of well developed bundles of pericyclic fibres, which are absent in case of Lobelia. The stem of Datura stramonium is similar in general structure with that of Belladonna, but many cells of the pith of D. stramonium contain cluster crystals of calcium oxalate and few sandy microspenoidal crystals, where as in case of Belladonna, the pith cells do not have the first type of cells but only latter type of crystals. For distinguishing the stem of Swertia chirata with that of S. angustifolia the measurement of the wings are taken into account for identification. Like this many more examples may be cited of various other parts of the plant viz. barks, roots, modified structures like rhizomes which can easily be distinguished by considering different parameters. Barks of Aspidiosperma spp. (98-102, 203) resemble with each other, to a great extent, in their macro and microscopical characters, but differentiated by the presence or absence of latex canals, sclerotic medullary rays, lignified and unlignified cork cells, arrangement of cortical sclereids, and phloem fibres and by the quantitative determination of sclereid fibre ratio. Cascara bark, due to its scarcity, is substituted by Almus glutinosa which can be differentiated by the presence of well defined band of sclereids in the pericycle, and the absence of phloem fibres (220). Presence or absence of stone cells and kinds of crystals present in the sheaths surrounding the fibres can distinguish Frangula and Oak barks (25). Differentiation of Cinchona, Cascara, Cinnamon and Sassafras barks depend on the dimensions of fibres,

as these barks have phloem fibres of varying dimensions (220). The particular arrangement of these fibres is often characteristic. In *Cinchona* they occur isolated or in short radial rows; isolated or in short tangential rows in *Cassia* and *Cinnamon*; in *witch Hazel*, *Cascara* and *Quillaia* they occur in tangential bands, four or five rows deep and extending from one medullary ray to another, while always isolated in *Aspidosperma excelsa*. Further, several quantitative methods based on the determination of sclereids in the mixed powdered drugs, have been utilised for their differentiation (58,172,214,216,217,231).

The measurement and the number of cork cells per unit area, presence of fibres in the secondary phloem, longer vessel elements, longer and more numerous xylem fibres, and absence of starch grains of more than three components, differentiate the roots of Indian Belladonna (*Atropa acuminata*) from the European species (*A. belladonna*) (111). Adulteration of Belladonna root by Marshmallow (*Althea officinalis*) root can be checked by its characteristic cell contents, as some mucilage and cluster crystals of calcium oxalate are found present in few cells of Marshmallow, and absent in Belladonna roots (212), and also the pentarch stele of *Althea officinalis* distinguishes it from Belladonna root, which has diarch stele. Due to superficial similarity the rhizomes of Dog-Grass (*Cynodon dactylon*) and *Agropyron repens* can be differentiated by the presence of two rings of sclerenchyma and absence of starch grain in *Agropyron* as compared to *Cynodon*, which has only one ring of sclerenchyma in the pericycle (194, 195). The rhizome of Swiss Ginger, adulterated with Japanese Ginger, can be differentiated by the presence of numerous compound starch grains of 3-15 diameter (197), and the rhizomes of *Xanthorrhiza apiifolia* and

Coptis teeta, which are adulterants of Hydrastis canadensis, have been differentiated by the peculiar structure of the pith cells and the pericycle. The number of internal glands in the rhizomes and the number of xylocentric vascular bundles in the stripe serve as useful distinguishing characters for D. filiximus and several other members of the family Polypodiaceae (117).

CHAPTER - II

PHARMACOGNOSTICAL AND PHYTOCHEMICAL
STUDIES ON ARALUKA

A. ARALUKA (Ailanthus excelsa Roxb.)

INTRODUCTION

Ailanthus excelsa Roxb. (Family - Simarubaceae) is a large, deciduous, 18 - 24 m. high tree. It is found almost throughout India, especially in Bihar, Chota Nagpur, Madhya Pradesh, Gujrat and in the forests of Ganjam and Vizagapatnam, and often planted in various parts of the country.

It is known with different names in different parts of the country. Some of the vernacular names are Ardusi, Mothoaraduso, Motoaduso (Guj.); Limbado, Maharukha (Hindi); Bende, Dodda, Doddabevu, Doddamara, Hebmani, Hem, Hire (Kan.); Peru, Mattipongilyam (Mal.); Adulsa, Adusa, Mahanimb, Maharuka (Marathi); Gorimakkaba, Mahala, Mahanimbu, Yoli (Oriya); Aralu, Atarusha, Madala, Mahanimba, Maharakha, Pisasha (Sans.); Agal, Naru, Peru, Peruppi, Pi, Perumaram (Tam.); Pedda, Peddamandu, Peddamanu, Peyyavepa (Tel.); Maharukh (Urdu).

In Ayurvedic System of Medicine the bark of this plant is considered to be refrigerant, astringent, appetiser, anthelmintic, febrifuge; considered to be used in complaints of children, used in diarrhoea, dysentery, earache, cures skin diseases, troubles of the rectum, fever due to "Tridosha", allays thirst; remove bad taste in the mouth; bark is also reported to be used for dyspeptic complaints, used as tonic, expectorant, and as antispasmodic and also given in chronic bronchitis and asthma.

The drug with the synonym Mahanimba forms a component of Ayurvedic preparations like Pusyanuga curna (synonym Katavanga), Brhanmanjisthadi-kvatha-curna and Mahavisagarbha taila. It is worth mentioning that the botanical identity given in the Ayurvedic Formulary of India (Part - I) to Mahanimba is Melia azedarach, while the same botanical identity is given to another plant called Bakain (syn. Mahanimba).

In other references (31,74-76) the vernacular names given to Araluka (Ailanthus excelsa) are Mahanimba and Bakain, which cause difficulty in identifying the exact drug.

REVIEW OF THE PREVIOUS WORK

Besides the presence of Ailantic acid (35) a number of chemical constituents viz. β -sitosterol, 2 : 6 diamethoxybenzoquinone, malanthin and a bitter principle have been reported (79,80). The bark also showed the presence of triacontane, hexatriacontane and a non-glycosidal bitter principle-Excelsin (110). Kapoor et. al. (1971) (85) isolated β -sitosterol and vitexin. A new 20-quassinoids from the alcoholic extract of the bark were isolated and one of the quassinoids identified as glaucurbin (91,92). Further, Bhatia et. al. (1983) reported the presence of a quassinoid 1 : 12 deoxy-13-formyl ailanthinol (15,16).

Inspite of the fact that the bark of Ailanthus excelsa is used in the indigenous systems of medicine, but very little pharmacognostical work has been done so far on the drug. Only Dennis et. al. (50) have studied the stem bark of this species, but without providing the details. Moreover, their findings also show inadequacy in their description. In view of this it was therefore, felt necessary to study the pharmacognostical aspects of the drug in detail and also elucidate the preliminary phytochemical aspects, as so far no record is available on the subject.

PRESENT INVESTIGATION

In the present investigation (Chapter - II), detailed macro and microscopical studies have been made on the young stem, young and

mature barks of Araluka. Attempts have also been made to study the cell contents, microchemical and the florescence characteristics, of the stem bark. The bark was also subjected to preliminary phytochemical studies in respect of determining the percentage extractives, examination of different extracts for different chemical constituents and determination of ash contents, alcohol and water soluble extractives. Thin layer chromatography (TLC) was also performed on the drug.

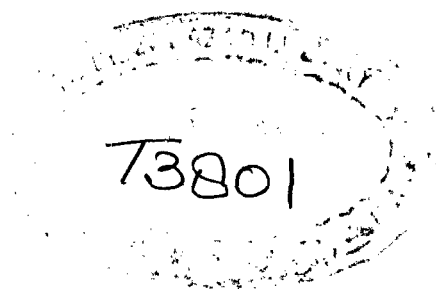




PLATE-IA



PLATE-IB

Ailanthus excelsa Roxb.

(PLATE - I)

A - Whole Plant

B - Leaves

EXTERNAL MORPHOLOGY OF THE PLANT

(PLATE - I)

The plant is a large, deciduous tree, measuring 18 - 24 m. in height and 2 - 7 m. in girth, with rough, light grey bark. Leaves unequally or equally pinnate, usually 20 - 30 cm., but sometimes reaching 60 - 90 cm. in length, the younger tomentose, older more or less so or glabrous, leaflets 8 - 14 pairs, alternate sub-opposite, very variable in shape, 10 - 15 cm. long, coarsely and irregularly toothed or sub-lobate, very unequal at the base; petiolules 2 - 5 cm. long. Flowers in large lax often much branched panicles, pedicels long, slender, calyx lobes ovate triangular. Petals 4 mm. long, ovate, lanceolate, glabrous, reflexed. Filaments glabrous, about half as long as the anthers. Samara 3.8 - 5.5 cm. long by 1 - 1.3 cm. broad, lanceolate, acute at both ends, reddish brown, twisted near the base, many nerved, nerves reticulate above the seed, otherwise nearly parallel. Seed solitary in the centre of the Samara (93,201,74-76).

The bark is bitter, and the wood is yellowish white and lustrous when first exposed, turning greyish white with age. It is very light, soft, and perishable (sp. gr., 0.45, air dry wt., 27 lb. per c. ft.). The tree yields an inferior type of Bassora or Hog gum (201).

PHARMACOGNOSTICAL STUDIES

MATERIALS AND METHODS:

Samples of the fresh stem, young and the mature barks of Araluka (Ailanthus excelsa) were collected from different localities of Ghaziabad and New Delhi, at different stages of growth. The details of the primary structures were studied by cutting the transverse section of the young stem and the secondary structure by cutting the young and mature barks. Market samples of the bark drug were also obtained from different market sources and compared with the authentic specimens.

For microscopical studies free-hand and hand-microtomic sections were cut, stained and mounted, using the usual plant microtechniques. Microchemical tests were performed on fresh sections as per the methods described by Kay (89), Johansen (81) and Trease (205). Small pieces of the material, from different portions were macerated separately in Schultz's fluid, washed with water, teased and mounted in glycerine for the study and measurement of the elements. The representative diagrams were drawn by using the Camera lucida. Powder of the bark drugs were examined under ultra-violet light according to the method given by Chase and Pratt (24).



PLATE - II A



PLATE - II B

MACROSCOPICAL FEATURES

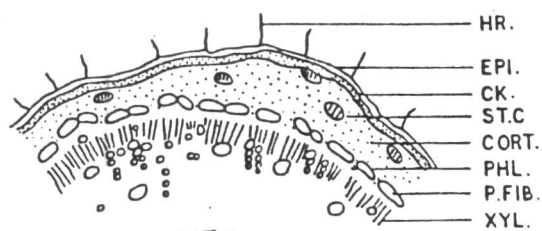
(PLATE - II)

A. Young Bark:

Bark is available in pieces, measuring 0.3 cm. to 0.5 cm. in thickness. They are light yellow to grey, curved and very light in weight. External surface is slightly rough showing leaf scars and shallow longitudinal striations. Internal surface is whitish grey to yellowish grey and smooth. Fracture is short in outer bark and splintery in inner bark. There is no characteristic odour and taste. (Fig. A)

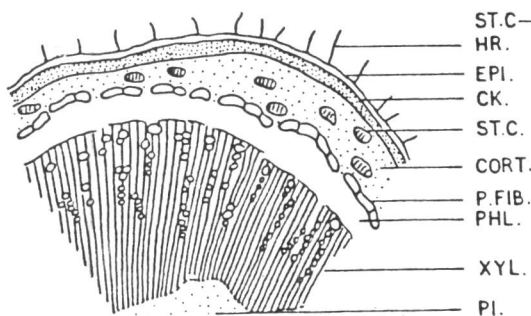
B. Mature Bark:

Bark is available in 1 - 2 cm. thick, light, and somewhat curved pieces. The external surface of the bark is light grey to greyish black and rough due to the deep, longitudinal fissures and transverse striations. The internal surface is light yellow to creamish yellow, rough and fibrous. The fracture is short in outer bark, splintery in inner bark and granular in transversely cut surface. It is odourless and bitter in taste, when soaked in water it swells greatly and becomes glutinous. (Fig. B)



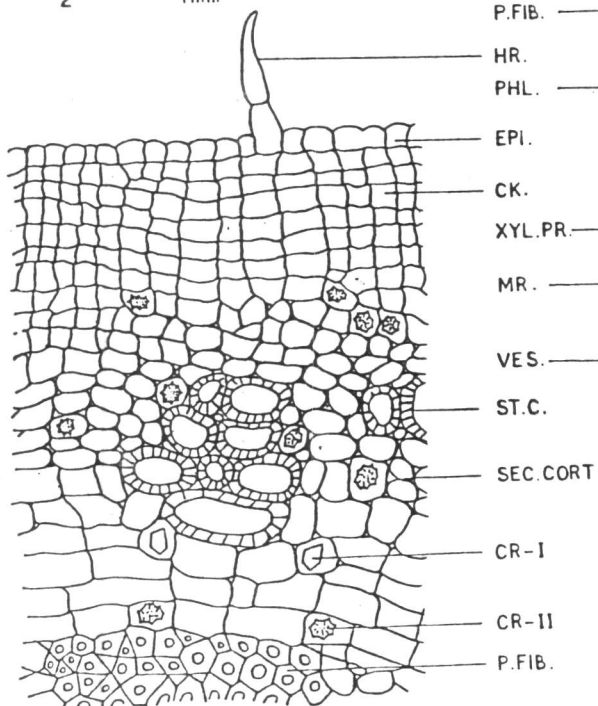
1

1mm



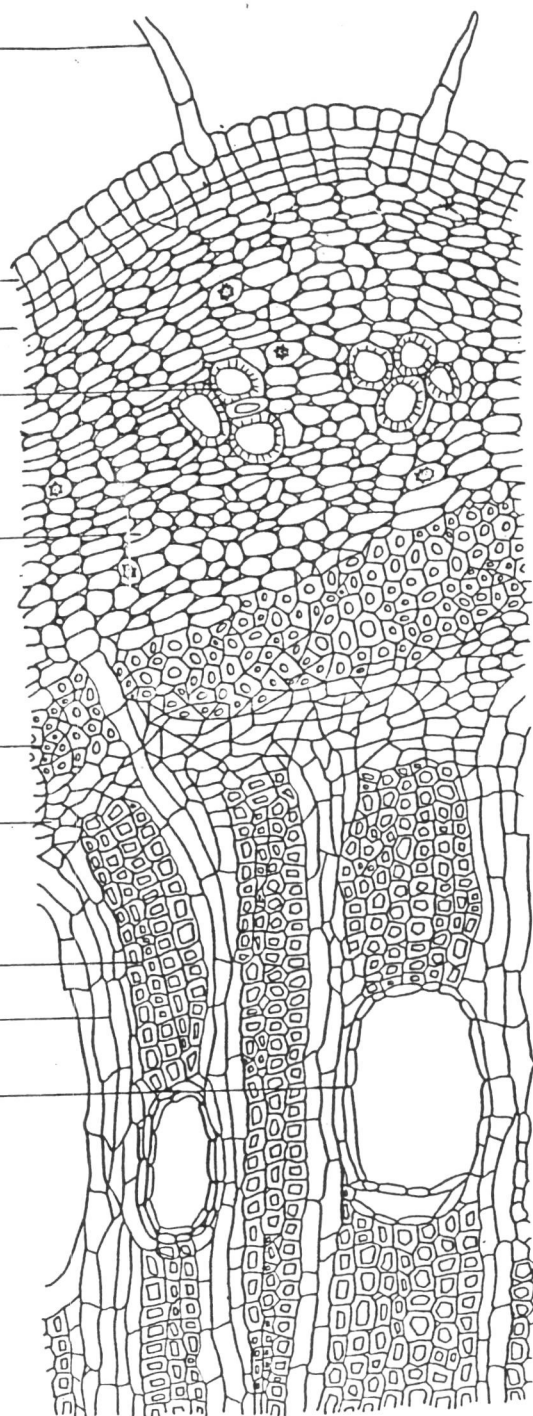
2

1mm



3

0.1mm



4

0.1mm

Ailanthus excelsa Roxb.

(PLATE - III, FIGS. 1 - 4)

- Fig. 1 : T.S. (Diagrammatic) of young stem showing hair (trichome), endarch vascular bundles with pericyclic fibres.
- Fig. 2 : T.S. (Diagrammatic) of mature stem showing endarch vascular bundles with pericyclic fibres.
- Fig. 3 : Details of T.S. of a portion of mature stem (upto pericyclic fibres).
- Fig. 4 : Details of T.S. of young stem showing hairs, epidermis, cork, cortex with stone cells and rosette crystals, medullary rays, phloem fibres, phloem, xylem parenchyma, and vessels.

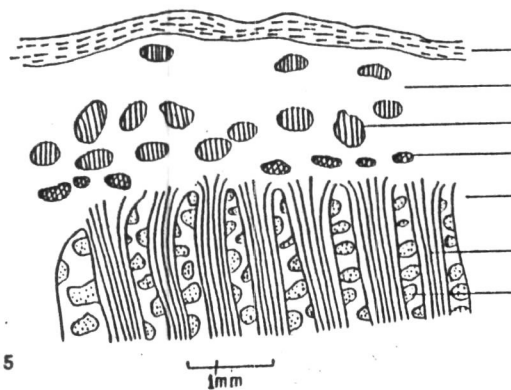
CK., cork; CORT., cortex; CR-I, prismatic crystal; CR-II, rosette crystal; EPI., epidermis; HR., hair; MR., medullary ray; P. FIB., pericyclic fibre; PHL., phloem; PI., pith; SEC. CORT., secondary cortex; ST. C., stone cell; VES., vessel; XYL., xylem; XYL. PR., xylem parenchyma.

MICROSCOPICAL CHARACTERS

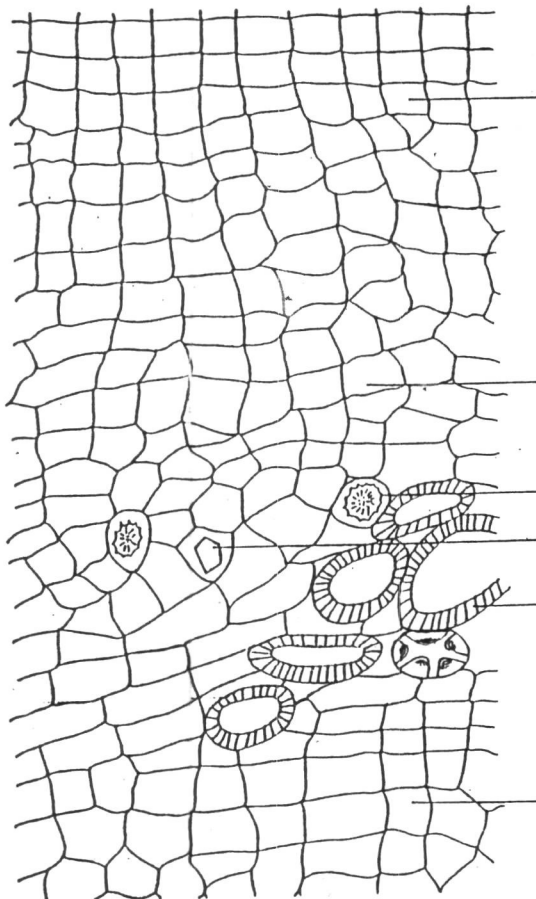
(PLATE - III - VI, FIGS. 1 - 10)

Young stem:-

Transverse section of young stem (Figs. 1 and 4) shows epidermis composed of cubical to barrel shaped, single layered, thin-walled cells covered with a thin, smooth, cuticle, some of the cells elongate to form uni to bicellular, uniseriate hairs with slightly rounded to pointed tips, and the base of the basal cell being broad. The cork cambium arises in sub-epidermal cells of the cortex at an early stage and the cork is composed of 3 - 4 layers of tangentially elongated, thin-walled cells. Cortex is a wide zone composed of 15 - 25 layers of rounded to oval, thin-walled parenchymatous cells. Stone cells are present either in singles or mostly in groups of 2 - 4 and even more. They are rounded, oval or elliptical of varying sizes with narrow to wide lumen, found scattered throughout this region. Few cortical cells contain rosette crystals of calcium oxalate. Pericyclic fibre patches are arranged in a concentric ring, traversed by medullary rays. The fibre cells are tetra to hexagonal in shape and lignified. The phloem is present below the pericyclic fibre ring, traversed by medullary rays. Phloem cells are thin walled consisting of tangentially elongated and irregularly arranged cells. Xylem consists of vessels and parenchyma traversed by medullary rays. Xylem parenchyma cells are thick walled, tetra to hexagonal, vessels mostly solitary or in groups of two and arranged in radial rows. Medullary rays 2 - 4 cells wide, consisting of radially elongated, thin walled cells, some ray cells extend upto the cortex, running straight in xylem region, while turn left or right in the phloem region. Centre is occupied by a wide pith consisting of thin walled, rounded, parenchymatous cells.



CK.
SEC.CORT.
ST.C.
P.FIB.
SEC.PHL.
MR.
PHL.FIB.
PHL.PR.



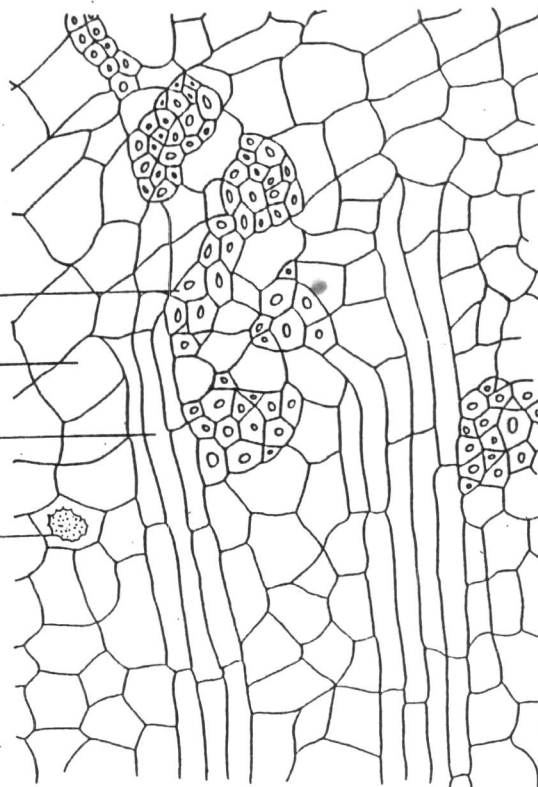
MR.
CK.
CR-II

SEC.CORT.

CR-II
CR-I
ST.C.

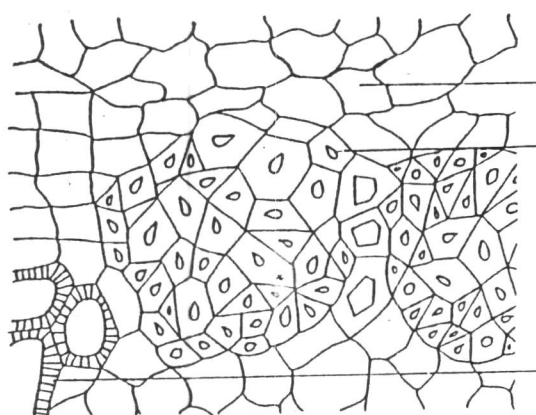
PHL.PR.
MR.
SEC.CORT.

PHL.FIB.

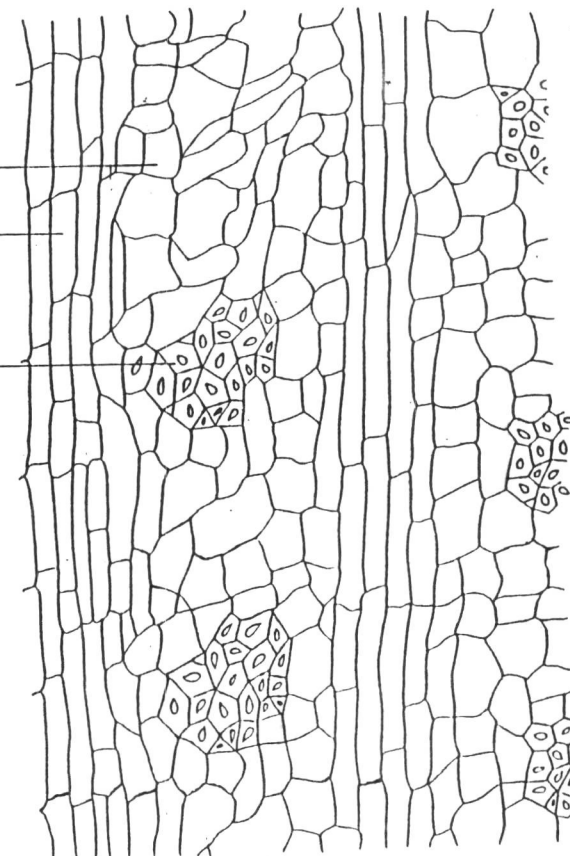


6C

0.1mm



SEC.CORT.
P.FIB.
ST.C.



6D

0.1mm

6B

0.1mm

Ailanthus excelsa Roxb.

(PLATE - IV, FIGS. 5 - 6D)

- Fig. 5 : T.S. (Diagrammatic) of a portion of young bark.
- Fig. 6A : Details of T.S. of a portion of young bark, showing cork, stone cells, prismatic and rosette crystals of calcium oxalate.
- Fig. 6B : Details of T.S. of a portion of young bark showing patches of pericyclic fibres, stone cells, and prismatic crystals of calcium oxalate.
- Fig. 6C : Details of T.S. of a portion of young bark showing secondary phloem with patches of phloem fibres, medullary rays and rosette type of calcium oxalate crystals in the phloem parenchyma.
- Fig. 6D : Details of T.S. of a young bark showing secondary phloem of middle region.

CK., cork; CR-I, prismatic crystal; CR-II, rosette crystal; MR., medullary ray; P. FIB., pericyclic fibre; PHL. FIB., phloem fibre; PHL. PR., phloem parenchyma; SEC. CORT., secondary cortex; SEC. PHL., secondary phloem; ST. C., stone cell.

Mature stem:-

Transverse section of mature stem (Figs. 2 and 3) shows cork consisting of 7 - 10 layers of thin walled, tangentially elongated and radially arranged cells. The epidermis and hair are similar in structure to those of the young stem. The cortex gets reduced due to the development of the cork and the secondary cortex. The cortical cells towards the cork consist of rounded to oval, thin walled parenchymatous cells with inter-cellular spaces, while towards pericycle they are thin walled and tangentially elongated. Stone cells are found scattered either singly or mostly in groups of 2 - 8 in the secondary cortex, and are larger in size with wide lumen, and shape is more or less same as in young stem. Some of the secondary cortical cells contain rosette crystals of calcium oxalate and a few prismatic crystals towards pericyclic fibres. Pericyclic fibre cells are similar to those of the young stem. The detailed structure of the phloem and xylem remain the same as in case of the young stem and no differentiating characters have been found.

Young bark:-

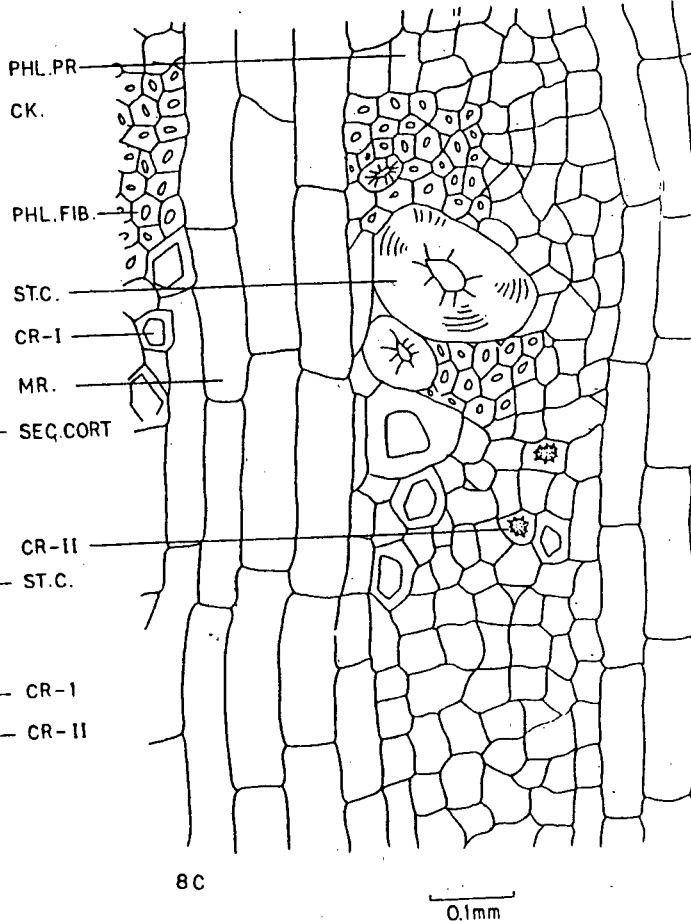
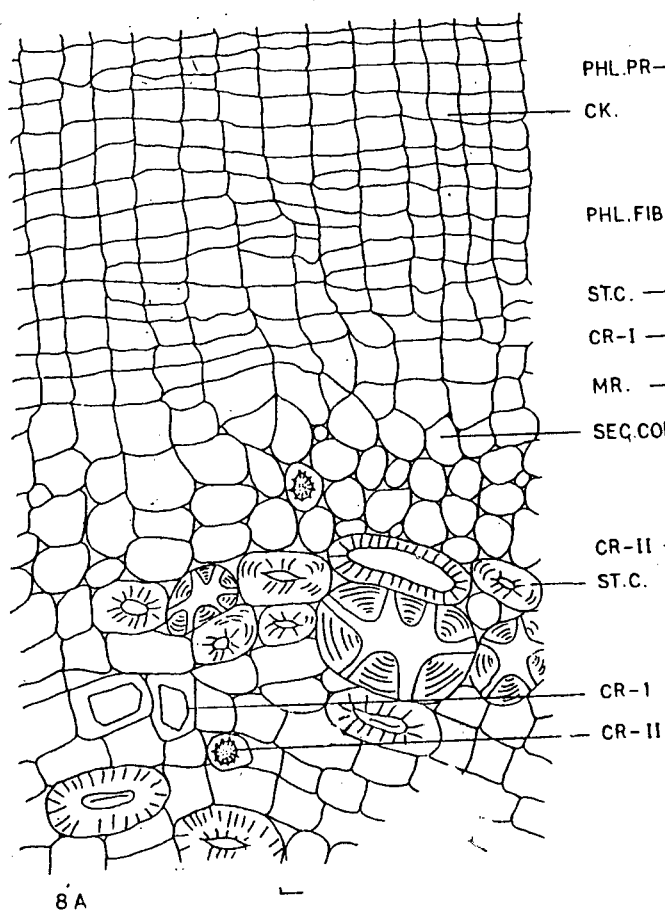
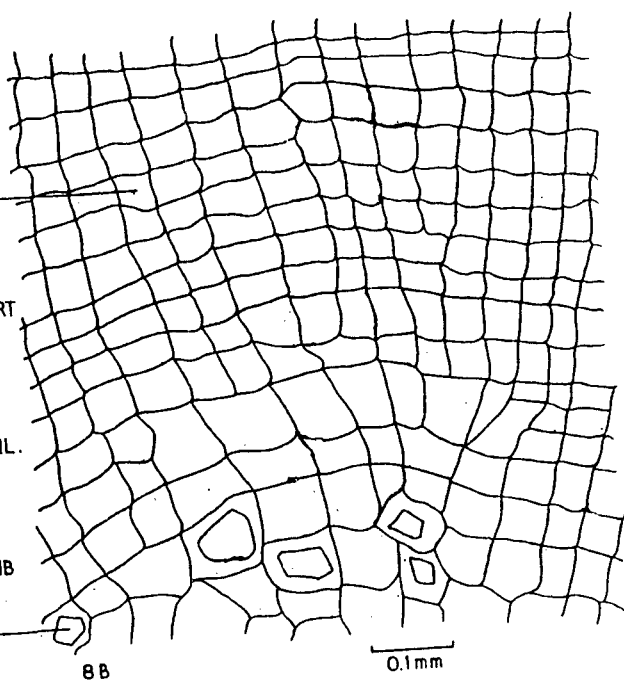
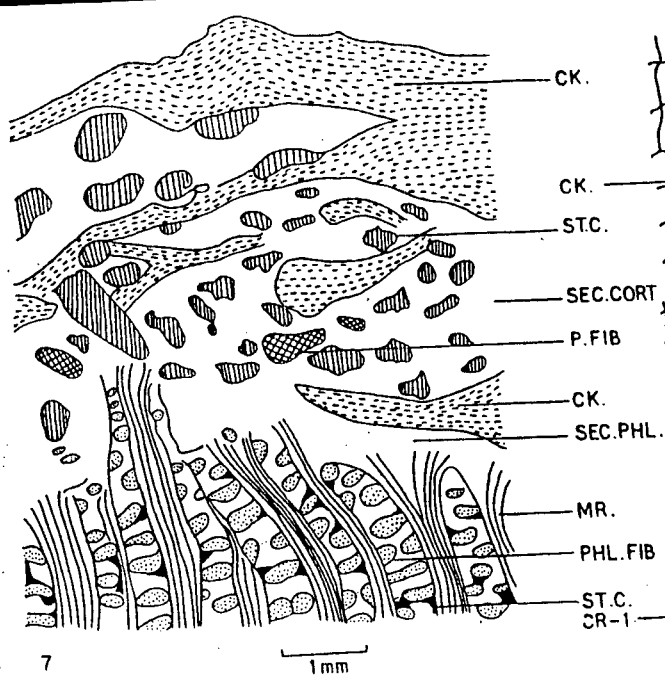
Transverse section of young bark (Fig. 5 - 6D) shows a wide zone of cork consisting of tangentially elongated and radially arranged cells. Secondary cortex consists of a wide zone of polygonal to tangentially elongated, thin walled, parenchymatous cells. Stone cells are found scattered in this region. They are rounded to oval, often single or mostly in groups of 2 - 4 or more of varying sizes, shape and thickness with mostly wide lumen. Both prismatic and rosette crystals of calcium oxalate are also seen present in this region (Fig. 6A). Pericyclic fibres are seen

present in patches. They are thick walled and tetra to hexagonal in shape. Prismatic crystals of calcium oxalate some times are seen in between the pericyclic fibre patches. Groups of 2 - 3 stone cells are also found scattered near by the pericyclic fibre patches (Fig. 6B), secondary phloem consists of phloem parenchyma and phloem fibre, traversed by medullary rays. Some of the phloem parenchyma cells contain only rosette crystals of calcium oxalate. Medullary rays are mostly straight and 1 - 4 cells wide consisting of radially elongated thin walled cells. (Figs. 6C and 6D)

Mature bark:-

The transverse section of mature bark (Fig. 7) shows formation of a number of strips of cork due to meristemisation, at places, of the cortical cells in secondary cortex. These strips sometimes unite with one another. In between these strips, mostly stone cells and sometimes few patches of pericyclic fibres are seen scattered.

The cork is composed of rectangular, tangentially elongated, thin walled and radially arranged cells (Fig. 8A). The structure of the secondary cortex is almost similar to that of the young bark except that a number of strips of cork are present (Fig. 7). The structure of these cork strips are similar to those described above. The secondary phloem (Fig. 8C) consists of phloem fibres and parenchyma traversed by medullary rays. The phloem parenchyma and fibres are similar in shape to those of the young bark. The phloem fibre patches are alternately arranged along the medullary rays. In between the phloem fibre patches, stone cells either singly or in groups of 2 - 3 are present, some stone cells are larger in size and mostly with narrow lumen. Some of the phloem

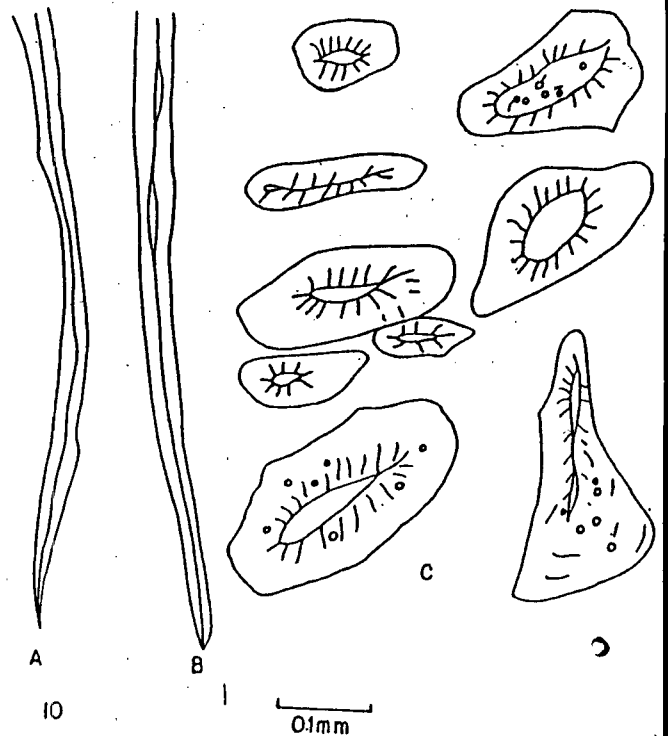
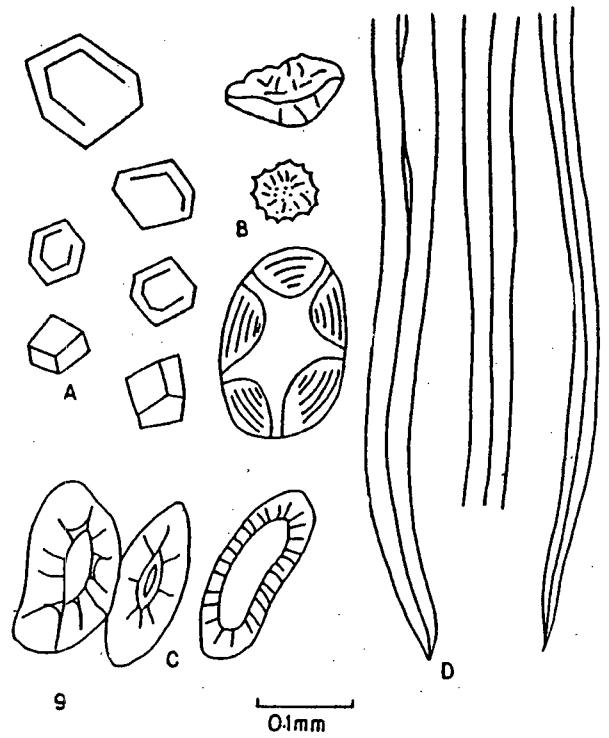
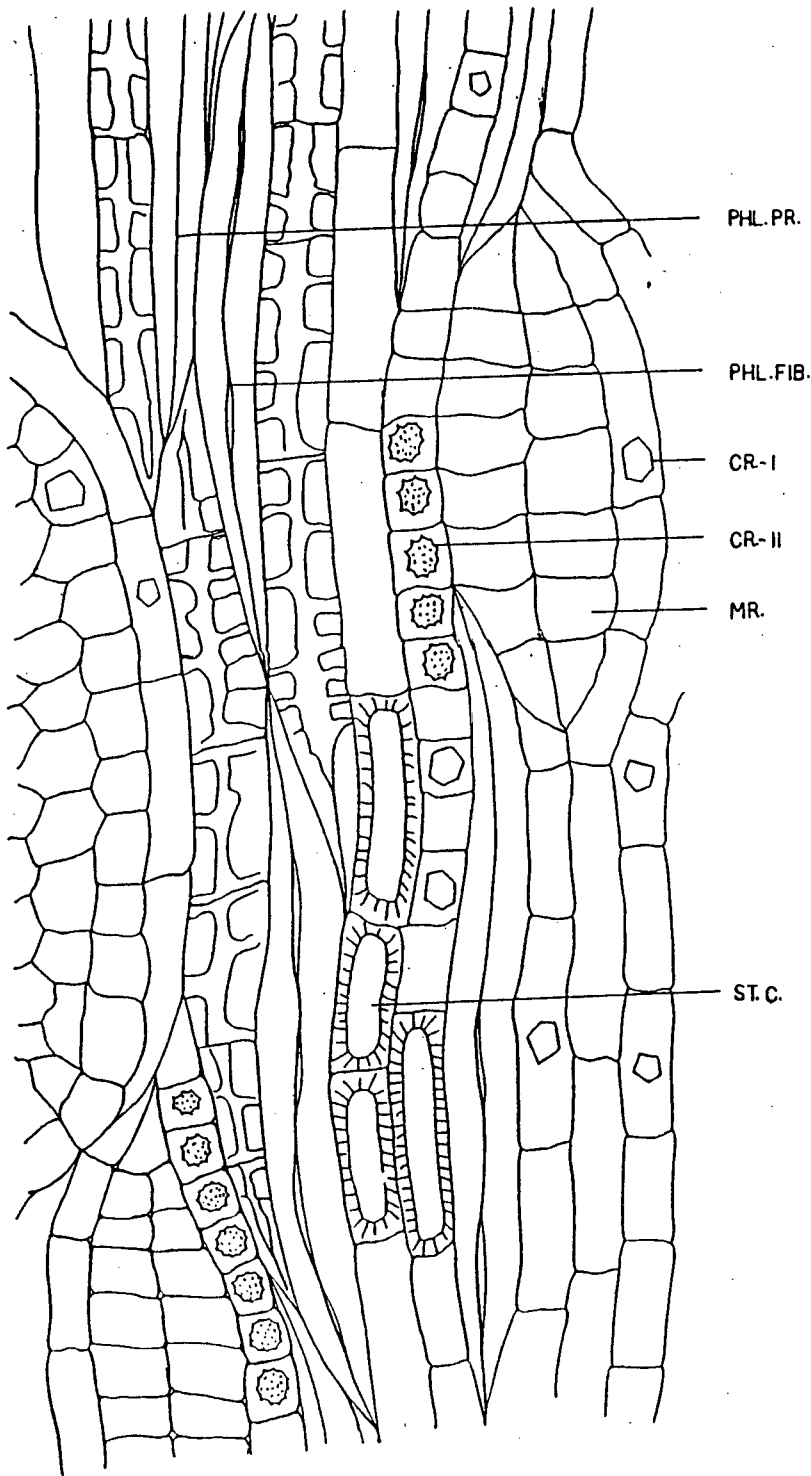


Ailanthus excelsa Roxb.

(PLATE - V, FIGS. 7 - 8C)

- Fig. 7 : T.S. (Diagrammatic) of a portion of mature bark.
- Fig. 8A : Details of T.S. of a portion of mature bark, showing cork, stone cells, prismatic and rosette crystals of calcium oxalate.
- Fig. 8B : Details of T.S. of a portion of mature bark showing inner cork and prismatic crystals of calcium oxalate.
- Fig. 8C : Details of T.S. of a portion of mature bark of the secondary phloem region showing phloem fibres, stone cells, phloem parenchyma, prismatic and rosette crystals.

CK., cork; CR-I, prismatic crystal; CR-II, rosette crystal; MR., medullary ray; P. FIB., pericyclic fibre; PHL. FIB., phloem fibre; PHL. PR., phloem parenchyma; SEC. CORT., secondary cortex; SEC. PHL., secondary phloem; ST. C., stone cell.



Ailanthus excelsa Roxb.

(PLATE - VI, FIGS. 8D - 10)

- Fig. 8D : Details of T.L.S. of a portion of the mature bark, showing phloem parenchyma, phloem fibre, prismatic and rosette crystals of calcium oxalate forming crystal sheath and stone cells.
- Fig. 9 : Macerated elements of the drug showing CR-I (prismatic crystal), CR-II (rosette crystal), stone cells and phloem fibres.
- Fig. 10 : Powder of the bark drug showing phloem fibres and stone cells.

CR-I, prismatic crystal; CR-II, rosette crystal;
MR., medullary ray; PHL. FIB., phloem fibre;
PHL. PR., phloem parenchyma; ST. C., stone cell.

A = Prismatic crystal; B = Rosette crystal;
C = Stone cell; D = Phloem fibre.

parenchyma cells, adjacent to phloem fibres and stone cells, contain both rosette and prismatic crystals of calcium oxalate, simple to compound and rounded to oval starch grains consisting of 2 - 3 components without conspicuous striation and central hilum, measuring 6 - 8 μ in diameter. Phloem fibres are thick walled, penta to hexagonal in shape with narrow lumen. Medullary rays are 1 - 9 cells and mostly 2 - 4 cells wide, straight, composed of radially arranged, thin walled cells, some cells containing prismatic crystals similar to those found in phloem parenchyma (Fig. 8C).

Transverse longitudinal section (TLS) of secondary phloem region of the bark (Fig. 8D) shows the presence of phloem parenchyma, phloem fibre, medullary rays and stone cells. The phloem fibres are thick walled, lignified with narrow to wide lumen, and have pointed to slightly rounded tips. Single rosette crystals of calcium oxalate are seen present in each phloem parenchyma cell forming a crystal sheath of 3 - 12 crystals. Some of the phloem parenchyma cells have single prismatic crystals of calcium oxalate which are also found scattered in the medullary rays. Stone cells are thick walled with narrow to wide lumen. Medullary rays 1 to 9 cells wide and 4 to 45 cells high and few ray cells containing prismatic crystals of calcium oxalate.

Macerated elements:-

Under microscope the macerated bark shows prismatic and rosette crystals of calcium oxalate of varying size and shape (Fig. 9A and 9B); single or groups of 2 - 3 rounded, oval to elliptical with narrow and wide lumen stone cells (Fig. 9C); aseptate, elongated fibres with pointed tips

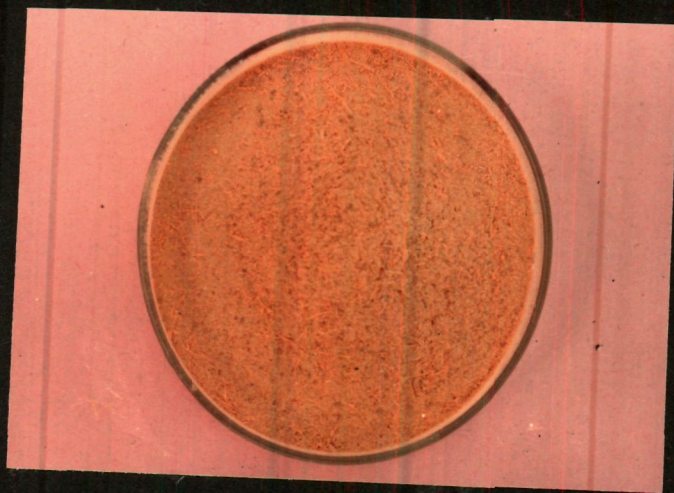


PLATE - VII

and narrow lumen (Fig. 9D).

Powder:-

Light yellow (PLATE - VII); under microscope shows single or groups of stone cells of varying size and shape (Fig. 10C); aseptate, elongated fibres with pointed and slightly rounded tips with narrow and wide lumen (Fig. 10A and 10B) (PLATE - VI).

CELL CONTENTS OF STEM AND STEM BARK:

Starch grains are present only in the mature bark. They are not present in the young and mature stem and the young bark. The starch grains are rounded to oval, simple as well as compound, having 2 - 3 components, mostly present in the phloem parenchyma and medullary rays. They do not show any conspicuous striations and are without central hilum, measuring 6 - 8 μ in diameter.

Both rosette and prismatic crystals of calcium oxalate are present throughout the cortical cells of young and mature stem and bark (young and mature).

In young stem only rosette crystals of calcium oxalate are present in few of the cortical cells, while few of the secondary cortical cells of mature stem contain rosette crystals of calcium oxalate and few prismatic crystals towards pericyclic fibres. Similarly both, rosette and prismatic crystals of calcium oxalate are present in young as well as mature bark. In the young bark, prismatic crystals of calcium oxalate are present between the pericyclic fibres, while the rosette crystals are present in some of the phloem parenchyma cells.

In mature bark both rosette and prismatic crystals of calcium oxalate are present in some of the phloem parenchyma cells. Single rosette crystals of calcium oxalate are present in each phloem parenchyma cells forming a sheath of 3 - 12 crystals. The prismatic and rosette crystals of calcium oxalate of varying size and shape (measuring 8 - 11 μ and 8 - 14 μ in diameter respectively) are seen present.

The alcoholic extract of the bark revealed the presence of sterol, tannin, saponin, and reducing sugar in addition to the above mentioned cell contents. However, the presence of alkaloid has been reported in leaves (187).

MICROCHEMICAL TESTS

The powder of dried stem bark was subjected to treatment with different chemical reagents, colour changes and other characteristics noted are given in the following table.

Reagent	Colour change	Inference
Powder + N/50 Iodine (cooled)	Turned blue	Starch present
Powder + Ferric chloride (5% soln.) + 10% Sodium carbonate	No change in colour	Tannin present
Powder + 1 drop Conc. sulphuric acid	Yellow colour changed to red within a minute	Saponin present
Powder + Conc. Hydrochloric acid	Crystals dissolved	Calcium oxalate present
Powder + Acetic anhydride heated + Sulphuric acid	Turned green blue to violet	Sterol present

Fluorescence Analysis:

The stem bark powder was examined under ultra violet light according to the method described by Chase and Pratt. The fluorescence characteristics of the stem bark powder seen are given in Table - I.

PHYTOCHEMICAL STUDIES

PRELIMINARY INVESTIGATIONS

Material used for the investigation:

10 kg. of the stem bark of Araluka (Ailanthus excelsa) was collected locally and from different localities of New Delhi for under taking the study. After drying the drug in shade, 5 kg. of the bark drug was powdered in moderately fine form for the extraction.

Determination of percentage extraction:

50 gms. of the powder drug was packed in soxhlet apparatus and successive extraction was done with the following solvents.

- i) Petroleum Ether (60^o - 80^o)
- ii) Solvent ether
- iii) Benzene
- iv) Chloroform
- v) Acetone
- vi) Alcohol
- vii) Distilled Water

Successive extraction was done in each solvent till it exhausted as shown by the disappearance of the colour of the extract through the siphon tube as well as the absence of any residue on evaporation of 5 ml. portion of the extract. After each extraction with one solvent, the drug powder was completely dried in air current before taking the drug for the next extraction in the second solvent of the successive order as given above.

Each extract was filtered and the volume was made to 100 ml. by adding the particular solvent in which the extraction was done. 250 ml. of each extractive were evaporated and the residue was dried to a constant weight in a tared porcelain dish. The percentage extractions of the drug with each solvent were calculated with reference to the air dried drug.

The nature, colour (under ordinary/u.v. light) of the extracts and percentage w/w of extractive values in different solvent are given in Table II.

Tests of different extracts with various chemicals for plant constituents:

When different extracts of the stem bark powder of Araluka (Ailanthus excelsa) were chemically tested for the presence of various chemical constituents viz. Sterol, Alkaloid, Saponin, Glycoside, Tannin, Flavonol and Sugar, the extracts gave positive tests for the presence of Sterol, Saponin and Sugars. The possibility of the presence of Glycoside, Tannin and Flavonol was ruled out, as all the chemical tests performed showed the negative results. The results thus obtained by performing various chemical tests are given in Table III.

TABLE - I

Fluorescence characteristics of the stem bark powder
under ultra violet light

Treatment	Fluorescence
Powder as such	Cream coloured
Powder treated with 1N NaOH in methanol	Yellowish green
Powder mounted in nitro-cellulose	Greenish yellow
Powder treated with 1N NaOH in methanol and mounted in nitro-cellulose	Light green

TABLE - II

Nature and colour (under ordinary/u.v. light) of extracts alongwith
percentage w/w extractive values in different solvents

S.No.	Solvent	Colour of the extract under ordinary light	Colour of the extract under u.v. light	Nature of the extract	Percentage in w/w of extractives
i)	Petroleum ether (60° - 80°)	Light yellow	Milky white with violet tinge	Normal	0.510
ii)	Solvent ether	Light lemon yellow	Milky brown with violet tinge	Slightly sticky	0.390
iii)	Benzene	Light brown	Light greenish	Normal	0.354
iv)	Chloroform	Brown	Greenish brown with milky tinge	-do-	0.312
v)	Acetone	Light brown	Greenish brown with milky tinge	-do-	1.120
vi)	Alcohol	Light brown	Greenish brown with milky tinge	Slightly sticky	3.010
vii)	Distilled Water	Dull brown	Greenish brown with milky tinge	-do-	4.500

TABLE - III

Tests performed for different chemical constituents in different extracts.

Solvent	Sterol	Alkaloid	Saponin	Glycoside	Tannin	Flavonol	Reducing Sugars
Petroleum ether (60° - 80°)	Positive	Negative	Negative	Negative	Negative	Negative	Negative
Solvent ether	-do-	-do-	-do-	-do-	-do-	-do-	-do-
Benzene	Negative	-do-	-do-	-do-	-do-	-do-	-do-
Chloroform	Positive	-do-	Positive	-do-	Positive	-do-	-do-
Acetone	-do-	-do-	-do-	-do-	-do-	-do-	-do-
Alcohol	-do-	-do-	Positive	-do-	Positive	-do-	Positive
Distilled Water	Negative	-do-	-do-	-do-	-do-	-do-	-do-

DETERMINATION OF ASH CONTENT AND EXTRACTIVE VALUES

Total ash content

Air dried powder drug was accurately weighed in tared silica crucible and incinerated at a low temperature until free from carbon. It was later on heated at a high temperature (400°C - 500°C) to the carbon particles from the residue. The crucible then was cooled in a desiccator and accurately weighed. Three readings were taken and the values were calculated with respect to the air dried weight of the drug.

The total ash and acid insoluble ash content were determined according to the methods given in Pharmacopoeia of India, 1966.

Stem bark

- | | |
|-----------------------|------------|
| a) Total ash | 8.100% w/w |
| b) Acid insoluble ash | 0.633% w/w |

Alcohol and water soluble extractives

The alcohol and water soluble extractive values were determined according to the methods given in Pharmacopoeia of India, 1966. The average values thus obtained are as under:-

Stem bark

- | | |
|-------------------------------|--------|
| a) Alcohol soluble extractive | 3.200% |
| b) Water soluble extractive | 4.170% |

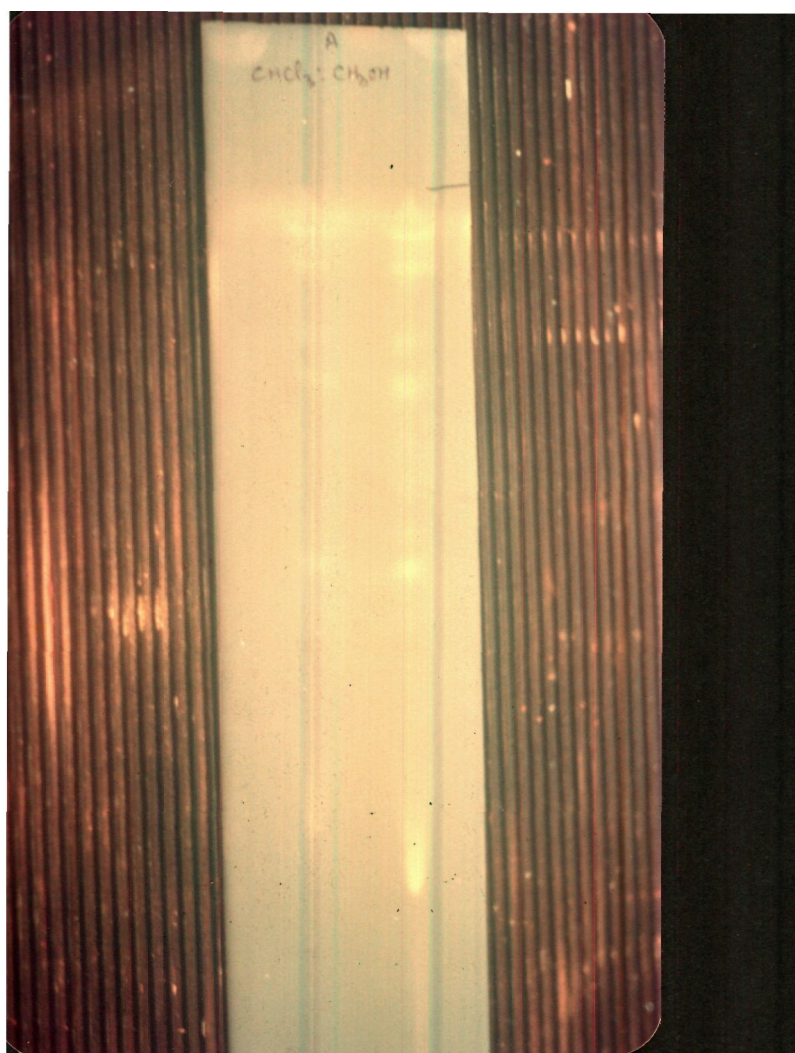


PLATE - VIII

THIN LAYER CHROMATOGRAPHIC STUDIES

For thin layer chromatographic studies of the stem bark of Araluka (Ailanthus excelsa), TLC plate of 20 X 5 cm. was coated with silica gel G and dried for 30 minutes at 110°C.

The chloroform extract was concentrated over water bath to 2 ml. and was spotted on the activated plate and allowed to run in chloroform : methanol (9 : 1) solvent system for a suitable distance. When the plate was observed in u.v. light, nine spots of different colours at the following Rf. values were observed (PLATE - VIII).

S.No.	Rf.	Colour
1.	0.103	Blue
2.	0.241	Blue
3.	0.289	Green
4.	0.358	Blue
5.	0.386	Green
6.	0.448	Green
7.	0.482	Blue
8.	0.551	Yellow
9.	0.965	Green

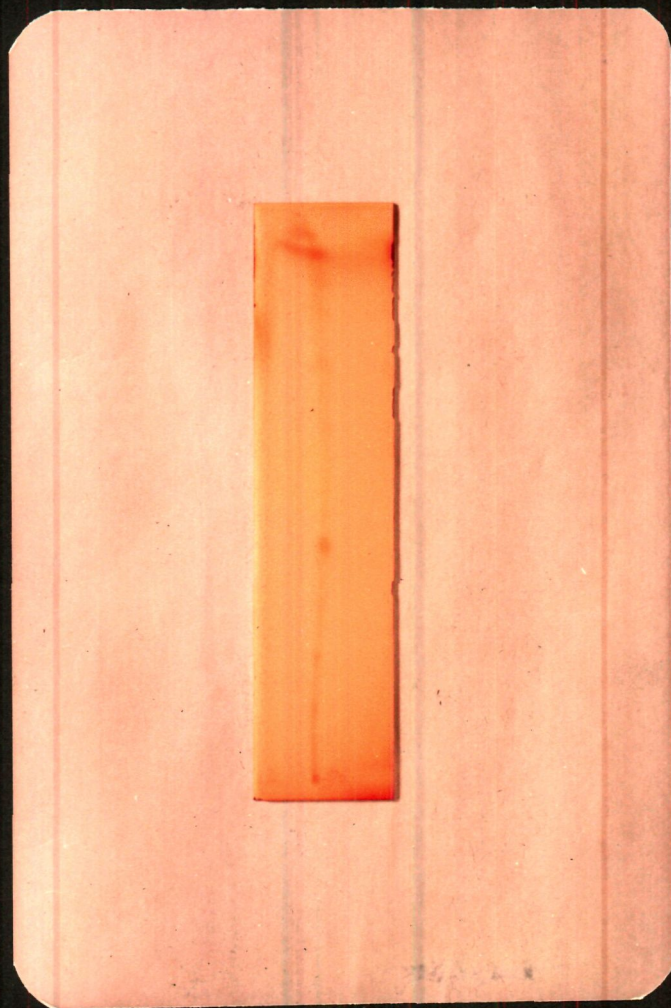


PLATE-IX

When the same plate was kept in iodine chamber for ten minutes six spots at the following Rf. values were observed (PLATE - IX).

S.No.	Rf.
<hr/>	
1.	0.200
2.	0.400
3.	0.481
4.	0.721
5.	0.802
6.	0.960

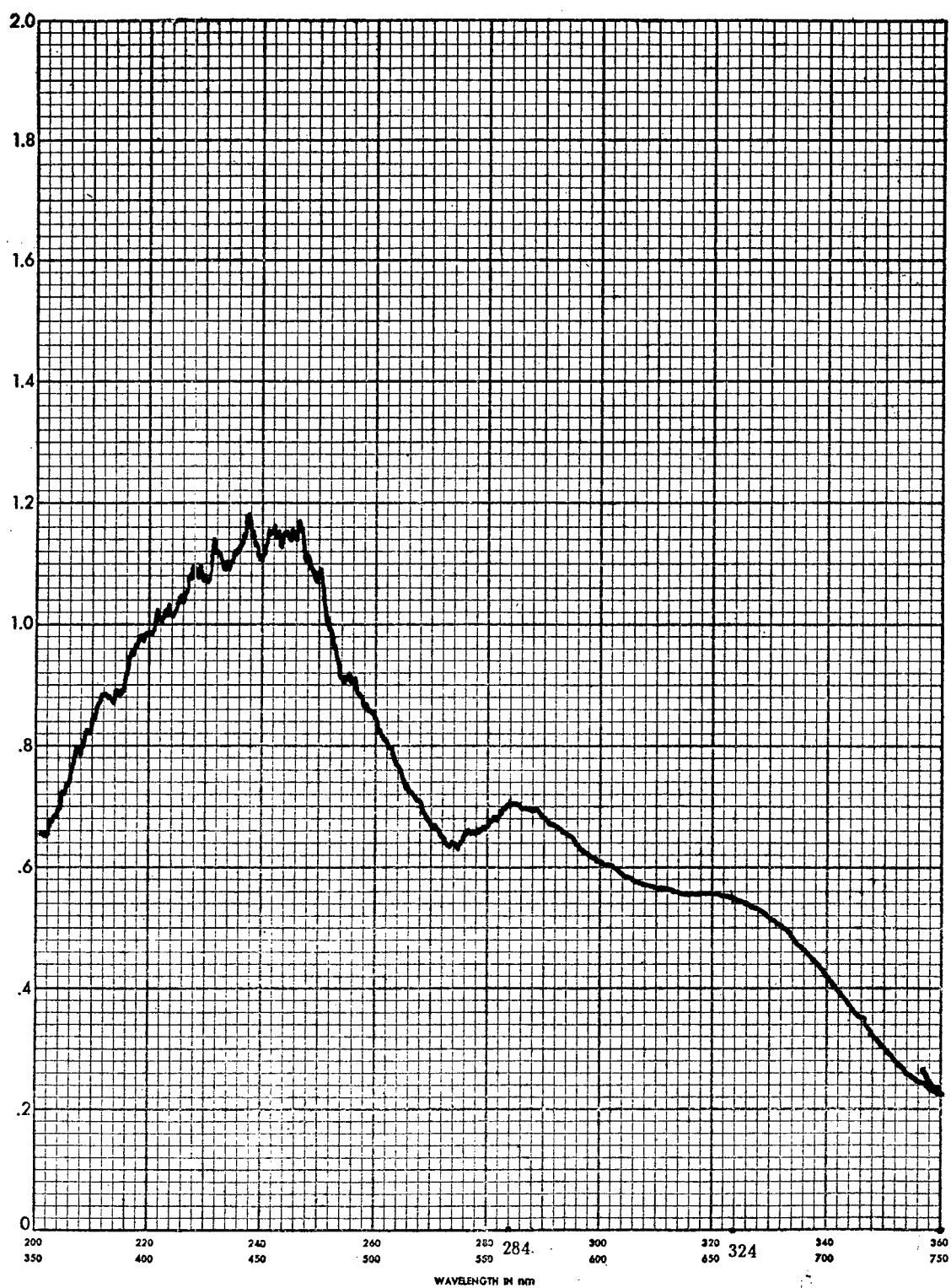


PLATE-X

U.V. SPECTROPHOTOMETRIC STUDIES

The chloroform extract (1 part) of Araluka (Ailanthus excelsa) was diluted in chloroform (99 parts) i.e. in ratio of 1 : 99 and was scanned in u.v. spectrophotometer (360 -200 n.m.) for the determination of the active constituents. Two peaks appeared in the u.v. region. The first, a broad peak at 284 n.m., and the other a relatively sharp peak at 324 n.m. (PLATE - X).

S U M M A R Y

The present study deals with the macro-microscopical, and phytochemical investigations of the stem bark of Ailanthus excelsa. The plant is a large tree, reaching a height of 18 - 24 m. and having a girth of 2 - 7 m. and having rough, light grey bark. Leaves are equally or unequally pinnate, flowers in large lax, often much branched panicles. Fruit is a Samara, 3.8 - 5.5 cms. long X 1 - 1.3 cms. broad. Seeds are solitary, present in the centre of Samara. The bark is bitter, and the wood is yellowish white, very light, soft and perishable. The tree yields an inferior type of Bassora or Hog gum. The young bark is available in pieces of 0.3 - 0.5 cms. in thickness, light yellow to grey, curved, and very light. Externally slightly rough in surface having leaf scars, and shallow longitudinal striations. Fracture is short and splintery. Mature bark is 1 - 2 cms. thick, light and somewhat curved pieces. External surface grey to greyish black and rough with deep longitudinal fissures and transverse striations. It is odourless and bitter in taste. When soaked in water swells and become glutinous.

Transverse section of young and mature stem of Araluka shows endarch vascular bundles, epidermis covered with thin cuticle, and uni- to bicellular hairs. The cork cambium arises in sub-epidermal cells. Stone cells present in single or in groups, and few rosette crystals of calcium oxalate are present in the cortical cells. Pericyclic fibre patches are present in a ring, followed by phloem and xylem. Transverse section of mature stem shows cork consisting of 7 - 10 layers of thin walled, tangentially elongated, radially arranged cells. Some of the secondary cortical cells of mature stem contain both rosette and prismatic crystals

of calcium oxalate. Transverse section of young bark shows a wide zone of cork. Stone cells are found scattered in the secondary cortex region along with the presence of both rosette and prismatic crystals of calcium oxalate. Pericyclic fibres are also present in the young bark, and some of the phloem parenchyma cells, contain only rosette crystals of calcium oxalate. In between the cork strips mostly stone cells and some times few patches of pericyclic fibres are seen present. The transverse section of the mature bark shows strips of cork due to meristemisation of the secondary cortical cells at places. The cork is composed of rectangular, tangentially elongated, thin walled and radially arranged cells. In between the phloem fibre patches stone cells either single or in groups are present, some cells are larger in size and mostly with narrow lumen. Phloem parenchyma cells, near to phloem fibres and stone cells, contain both rosette and prismatic crystals of calcium oxalate. Simple to compound, rounded to oval with 2 - 3 components of starch grains are present. Phloem fibres are thick walled, penta to hexagonal with narrow lumen. Some of the medullary ray cells contain prismatic crystals. Transverse Longitudinal Section of secondary phloem region shows the presence of rosette crystals of calcium oxalate, present singly in each phloem parenchyma cell forming a crystal sheath of 3 - 12 crystals. Some of the phloem parenchyma cells have single prismatic crystals of calcium oxalate, which are also present scattered in medullary rays. Stone cells are thick walled with narrow to wide lumen, and few ray cells containing prismatic crystals of calcium oxalate. Under ultra violet light the bark powder when treated with 1N NaOH and mounted in nitrocellulose exhibits a light green fluorescence. The total and the acid insoluble ash of the

bark are found to be 8.100% and 0.633% respectively. T.L.C. was also performed on the bark of Araluka. Under u.v. the plate showed seven spots of different colours with Rf. values- 0.531, 0.593, 0.718, 0.750, 0.825, 0.906 and 0.960. The u.v. spectrophotometric studies of the bark revealed the presence of two peaks, one broad at 284 n.m. and second relatively sharp at 324 n.m.

B. KATPHALA (Myrica nagi Thumb.)

INTRODUCTION

Myrica nagi Thumb. (Family - Myricaceae), is a small or moderate sized, evergreen tree, reaching a height of 3 - 15 m. It is found in sub-tropical Himalayas from Ravi eastward to Assam and in Khasi, Jaintia, Naga and Lushai hills at an altitude of 900 - 2,100 m.

The fruits of the plant are edible. They have a pleasant, sourish-sweet taste, and are used in the preparation of a refreshing drink. The fruits are covered with crust of white waxy material, permeated with brown and black spots. Other botanical names given to this plant species are M. esculenta Buch-Ham. syn., M. farquhariana Wall. and M. sapida Wall (201).

It is known with different names in different parts of the country. Some of the vernacular names of the species are Kaiphal, Kayaphul, Satsarila (Beng.); Kaiphal, Kayaphala (Bombay); Kariphala (Guj.); Kaephal, Kaiphal (Hindi); Maruta (Mal.); Kayaphala (Mara.); Kahela, Kahi, Kaphal (Punj.); Aranya, Bhadra, Bhadravati, Kaitarya, Katphala, Kayaphala, Krishnagarbha, Kumbhi, Somavriksha (Sansk.); Marudam (Tamil); Kaidaryamu (Tel.) and Kaifal in (Urdu) (83,84).

Both bark and fruits of Katphala or Kaiphal (Myrica nagi) or Box Myrtle (English) are reported to be used in Ayurveda and Unani system of Medicine for curing different diseases. The bark of this species in Ayurveda is reported to be acrid, bitter, and pungent. It is reported to be useful in fever, asthma, urinary discharges, piles, bronchitis, throat complaints, tumours, anaemia, chronic dysentery and ulcers. It is also described to be a good snuff in headache and used as a useful collyrium in eye diseases, and described to be useful in 'Vata' and 'Kapha'.

Similarly in Unani system the bark of this species is reported to be used as tonic, carminative, and has a sharp, bitter and astringent taste. It is reported useful in inflammation, headache, nasal catarrh, piles, liver complaints, sores, chronic bronchitis, and asthma. It is also considered good uterine stimulant (83,84,93,94).

Though in modern literature, available on the subject, a number of medicinal properties as mentioned above, are attributed to the bark of this plant species for curing various ailments, but in the classical literature of Ayurveda, it has been noticed that there is a very little use of the bark of this plant species. In Ayurvedic Formulary of India, Part - I, there is only one formulation called Nyāgrodhādī-Kvāth-Çūrṇa with the synonym Somavalka (Katphala), where the bark is used as one of the ingredients. Some of the important formulations of Ayurveda, where the fruit has been mentioned as important ingredient are Brhatphala ghrta, Puṣyānug Çūrṇa, Arimedādī taila, Bala taila, Mahāviṣāgarbha taila, Khadirādī gutika (Mukharoga and Kasa), Aṣṭāṅgavaleha, Devadurvādī-Kvātha-Çūrṇa, Katphalādī Çūrṇa. In Unani System, where the bark of this plant is used as important ingredient are Habb-e-Munaish, Habb-e-Mubarak and Raughan-e-Surkh etc. (83,84,118).

Here it is worth mentioning that the drug name Somavalka has also been mentioned as synonym of the drug Khadir (Acacia catechu) in the formulation Mūtrasangrahaniya-Kaṣāya-Çūrṇa, which is described to be used in the form of heartwood and not the stem bark.

REVIEW OF THE PREVIOUS WORK

Though, as compared to fruits, the bark of Katphala has limited use in Ayurveda, but in Unani System the stem bark of the drug is used

in a number of formulations as mentioned earlier. But there is no pharmacognostical work except that of Nayar et. al. (119), and phytochemical data available on the drug, inspite of its greater use in Unani to cure different ailments already described. It was therefore, decided to take up the present study in order to establish its exact identity and as well as lay down distinguishing characters to avoid the controversy of identifying the genuine material specially with that of Acacia catechue (Khadira), which is used in place of Katphala (Somavalka) in some of the formulations of Ayurveda in the form of heartwood, as already mentioned above.

The Katphala (Myrica nagi) bark is reported to contain a yellow colouring matter and rich in tannin. It has been used occasionally as a tanning and dyeing material. The yellow colouring matter, myricetin (hexahydroxy flavone, $C_{15}H_{10}O_8$, m.p. 35 - 57⁰) occurs in the bark in the form of the glycoside, myricitrin (myricetin 3-rhamnoside, $C_{21}H_{20}O_{12}$, m.p. 199 - 200⁰). A second glycoside, the aglycone of which is possibly quercetin, is present in traces. Some specimens of the bark are exceedingly rich in colouring matter. The tannins of the bark belong to the pyrogallol group and 0.73% of the total tannins can be extracted with water. Analysis of bark gave the following values:- moisture, 10.5%; tannins, 32.1%; soluble nontans, 10.7%; and insolubles, 46.6%; tan, non-tan ratio 2.9 (Karrer 628; Perkin and Everest 220 - 23; Santhanam and Bratt, Bull. Cent. Leath. Res. Inst., Madras, 1960 - 61, 7, 20). A phenolic component-myricinol has also been reported from the stem bark (95,96,199,200).

PRESENT INVESTIGATIONS

In the present investigation (Chapter - III), detailed macro and microscopical studies have been made on the stem bark (thin and thick) of Katphala. Cell contents have been studied, fluorescence characteristics observed, and microchemical tests have been performed. The stem bark was also subjected to preliminary phytochemical studies in respect of determination of extractive percentage, different chemical constituents in different extractives, ash content, alcohol and water soluble extractives. Thin Layer Chromatography (TLC) was also performed. The u.v. spectrophotometric studies on the bark drug have also been undertaken. The drug gave a single sharp peak at 294 n.m.



PLATE - XI

Myrica nagi Thumb.

(PLATE - XI)

Whole Plant

EXTERNAL MORPHOLOGY OF THE PLANT

(PLATE - XI)

The plant is a small or moderate sized evergreen tree, measuring 3 - 15 m. in height, with rough, brownish grey bark, having deep vertical wrinkles. Branchlets are pubescent with young shoots, petioles and inflorescence tomentose. Leaves are lanceolate, oblong obovate, crowded towards the ends of the branches, 7.5 - 12.5 by 2.5 - 5 cms.; narrowed at both the ends, entire, obtuse, acute or acuminate, sharply serrate, with resinous glands beneath, glabrous when mature, coriaceous, petiole 7.5 - 15mm. long. Flowers are minute, unisexual arranged in axillary spikes. Male spikes are 7.5 mm. long, arranged racemosely on a common axillary stalk, 2.5 - 7.5 cm. long, while female spikes are also axillary, erect, 1.3 - 2.5 cm. long. Bracts are orbicular, often with 2 - 3 smaller lateral ones, and stamens 3 - 6. Fruit is a ellipsoid or ovoid drupe of the size of the cherry, tubercled, reddish or cheese coloured when ripe, with rugose nut.

PHARMACOGNOSTICAL STUDIES

MATERIALS AND METHODS

Samples of the fresh and mature stem bark (thin and thick) of Katphala (Myrica nagi) were collected from different localities of Nainital and Almora districts, while market samples of the mature bark were procured from different market sources of Delhi, which were compared with the authentic and genuine samples available in the Herbarium and Museum of the Laboratory. The detailed microscopic characters were studied by cutting the transverse sections of both thin and thick pieces of the mature bark of Katphala.

For microscopical studies free hand, and hand microtome sections were cut, stained and mounted using the usual plant microtechniques. Microchemical tests were performed on fresh sections as per the methods described by Kay (89), Johansen (81) and Trease (205). Small pieces of the material, from different portions were macerated separately in Schultz's fluid, washed with water, teased, and mounted in glycerine for the study and the measurement of the cell contents. The representative diagrams were drawn by using the Camera lucida. Powder of the bark drugs were examined under ultra-violet light according to the methods given by Chase and Pratt (24).



PLATE - XIIA



PLATE-XIIB

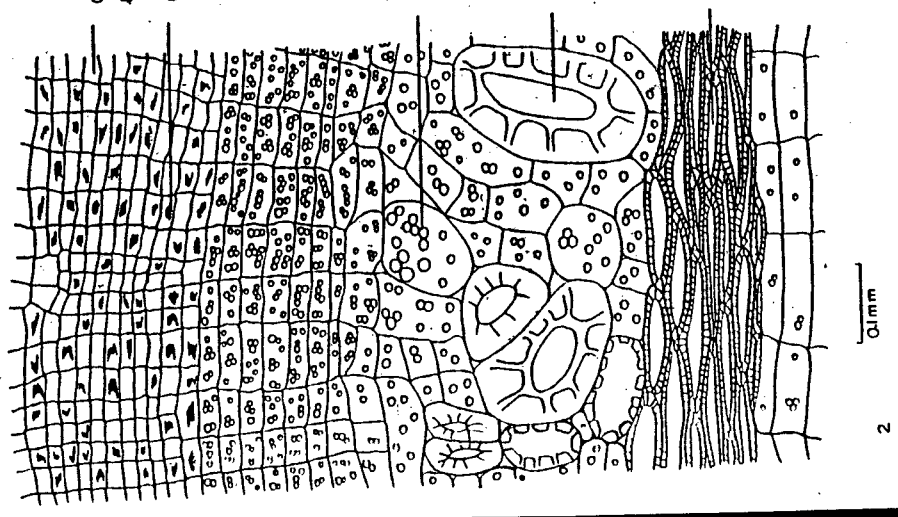
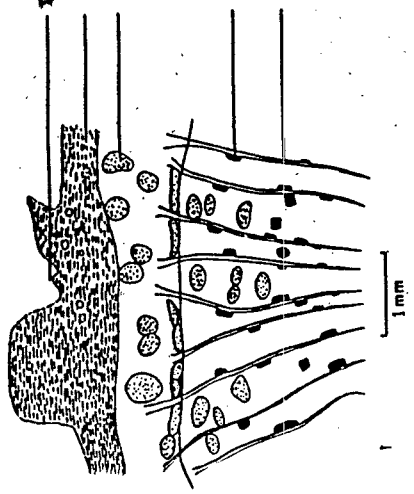
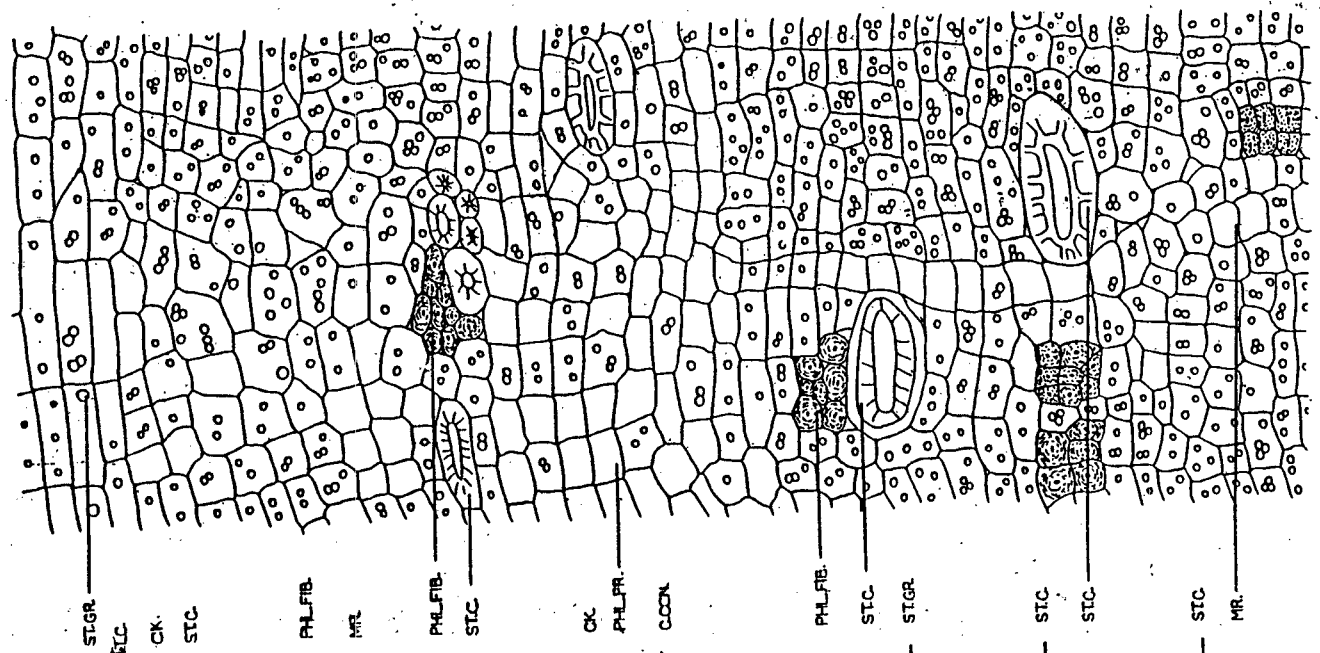
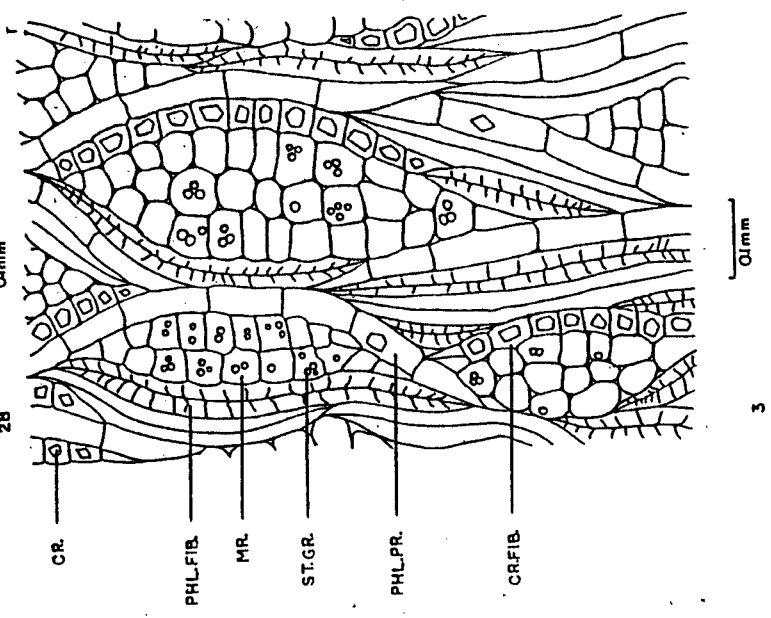
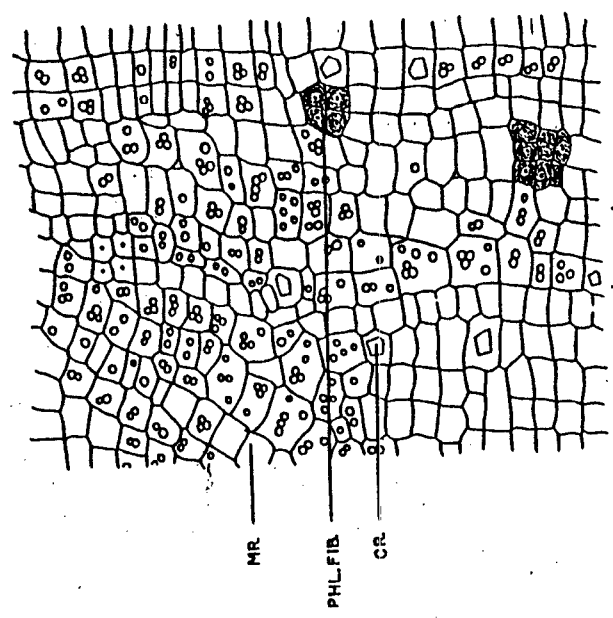
MACROSCOPICAL FEATURES

(PLATE - XII A & B)

The bark is available both in the form of thick and thin pieces.

Thin bark pieces (PLATE - XII A) are 0.2 - 0.5 cm. in thickness, channelled, quilled and light in weight. External surface is rough, greyish brown in colour, showing numerous transversely arranged whitish lenticels, and thin, longitudinal striations. Internal surface is smooth and reddish brown in colour and fracture short.

Thick bark pieces (PLATE - XII B) measure 0.5 - 2.0 cm. in thickness. They are channelled and heavy in weight. External surface rough having longitudinal and transverse wrinkles, greyish brown with whitish scars of lichens, and fracture short. The bark is odourless and astringent in taste.



Myrica nagi Thumb.

(PLATE - XIII, FIGS. 1 - 3)

- Fig. 1 : T.S. (Diagrammatic) of thin bark showing cork, stone cells, phloem fibre patches and medullary rays.
- Fig. 2 : Details of T.S. of a portion of the thin bark showing cork with cell contents, starch grains and the stone cells.
- Fig. 2A : Details of T.S. of a portion of the secondary phloem of the thin bark showing starch grains, phloem fibres and medullary ray.
- Fig. 2B : Details of T.S. of a portion of inner secondary phloem of the thin bark showing medullary ray, starch grains, phloem fibres and prismatic crystal of calcium oxalate.
- Fig. 3 : Details of T.L.S. of a portion of the thin bark showing prismatic crystal of calcium oxalate, phloem fibres, medullary ray, starch grains, phloem parenchyma and crystal fibres.

C. CON., cell content; CK., cork; CR., crystal (prismatic); CR. FIB., crystal fibre; LT. C., lenticel; MR., medullary ray; PHL. FIB., phloem fibre; PHL. PR., phloem parenchyma; ST. C., stone cell; ST. GR., starch grain.

MICROSCOPIC CHARACTERS

(PLATE - XIII, XIV, XV, FIGS. 1 - 10)

Thin bark

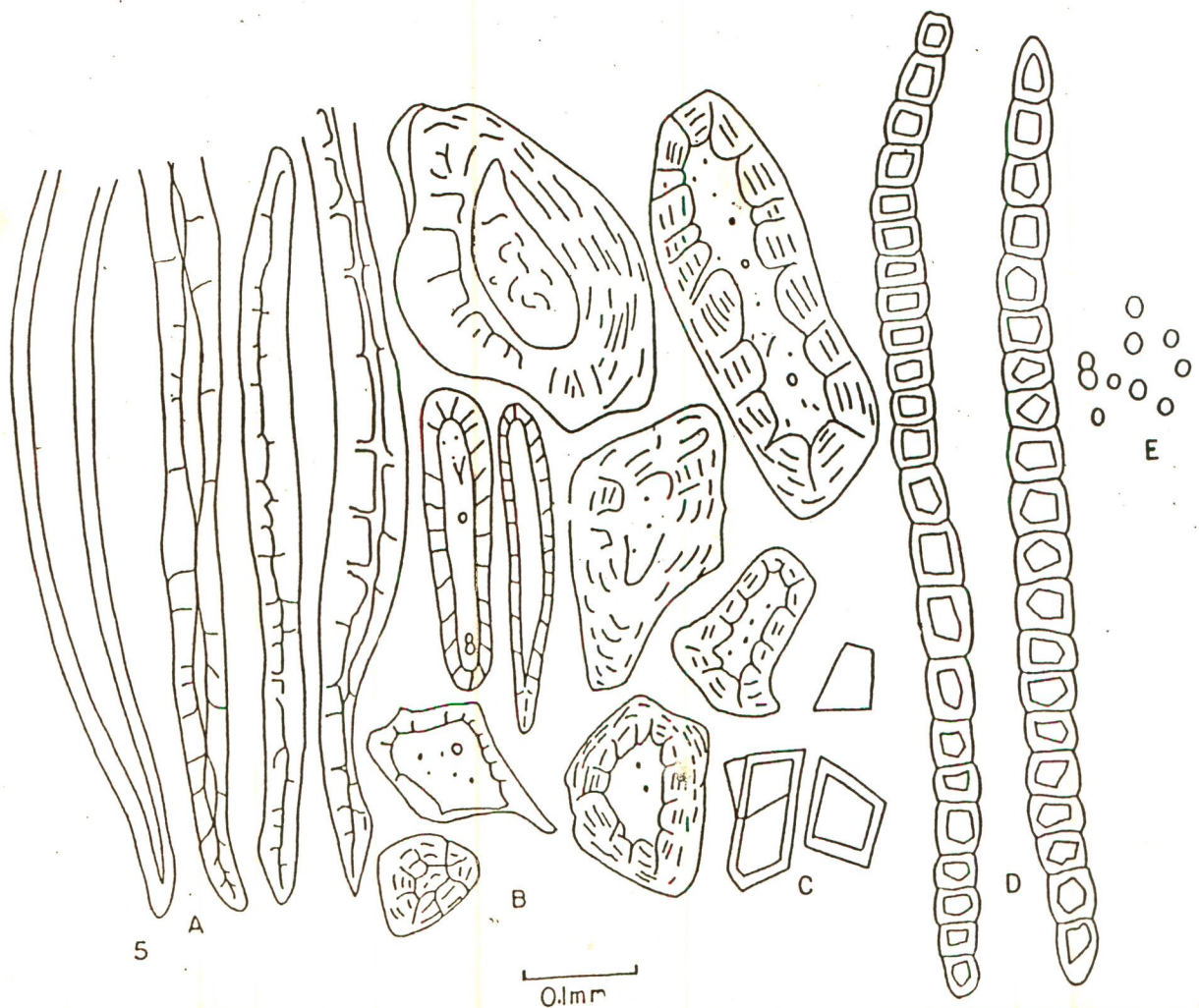
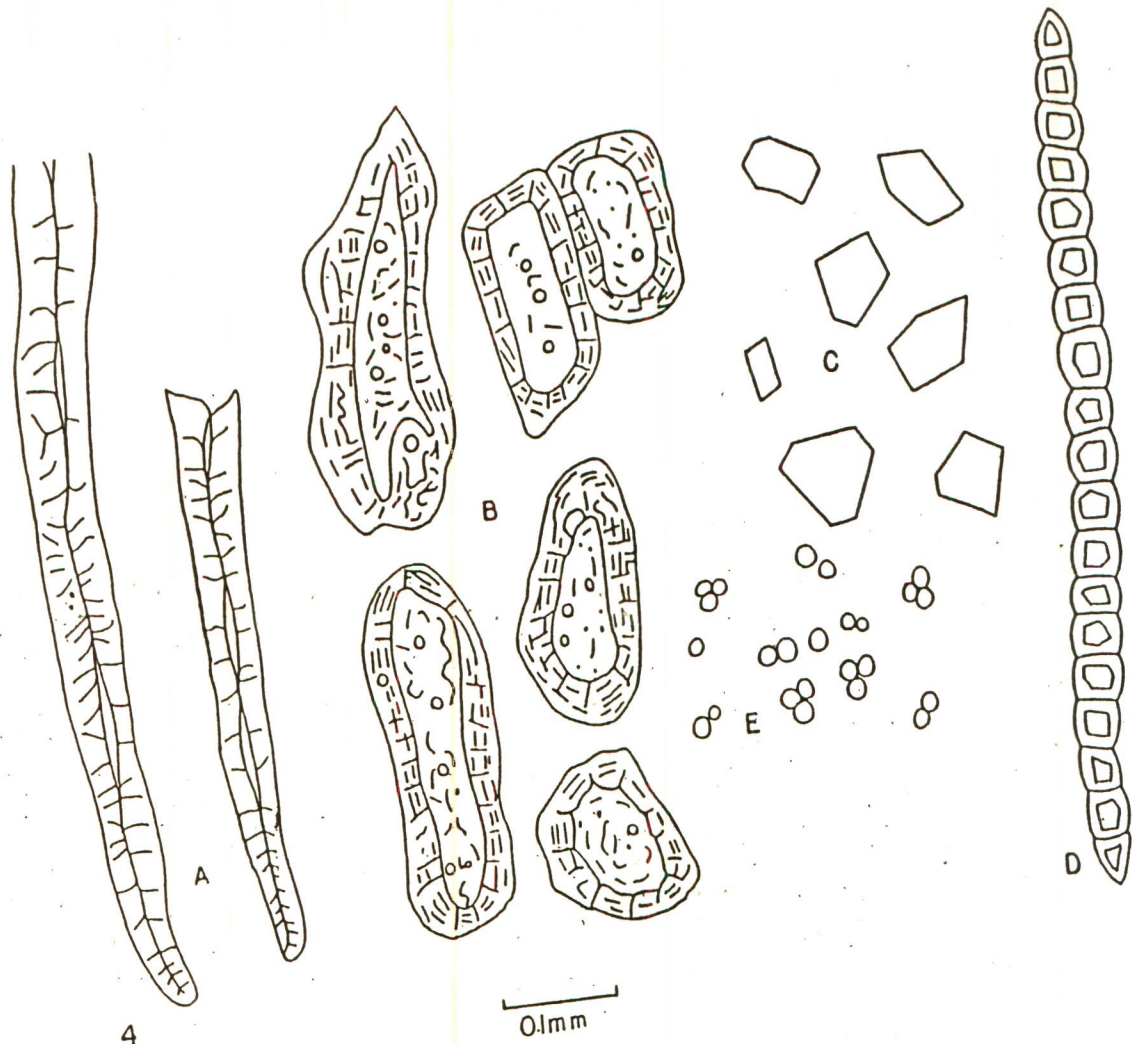
Transverse section of thin bark (Fig.2) shows a wide zone of cork consisting of thin walled, tangentially elongated and radially arranged cells having yellowish brown contents. Secondary cortex is a wide zone, differentiated into three regions. The outer most region is narrow, composed of 4 - 8 rows of elongated, rectangular, thin-walled cells filled with simple as well as compound starch grains. The middle region of the secondary cortex consisting of rounded, oval, elongated and elliptical, thin walled parenchymatous cells, filled with simple and compound starch grains slightly bigger in size. A number of stone cells are found scattered in this region. They are in singles or in groups of 2 - 3 of different shape and size, arranged radially and also tangentially and have radiating canals. Some of these are with concentric striations and narrow to wide lumen. The inner cortical region is composed of mostly stone cells which are elliptical and elongated in shape. They are comparatively smaller in size, tangentially arranged and compact.

Secondary phloem (Fig.2A) is composed of phloem parenchyma, phloem fibres and stone cells traversed by phloem rays. Phloem parenchyma consists of rectangular to polygonal cells, most of the cells contain simple to compound starch grains. Compound starch grains composed of 2 - 3 components. Simple grains measuring 3 - 14 μ in diameter. Prismatic crystals of calcium oxalate present in some of the phloem parenchyma cells towards inner side (Fig.2B). Phloem fibres are found scattered throughout the secondary phloem in groups of 3 to 10 cells, having thick

walls and narrow lumen. They are rounded to oval in shape. Stone cells of various shape and size having narrow to very wide lumen with radiating canals are present scattered in this region. They are in singles or in groups of varying numbers found distributed in outer and middle zone of secondary phloem. Phloem rays are many in number, extended upto the secondary cortex region traversing in between stone cell groups, where they are slightly expanded. The ray cells are oval to rectangular in shape filled with yellowish brown contents, and less abundant simple and compound starch grains.

Transverse longitudinal section of the secondary phloem region of the bark (Fig.3) shows phloem parenchyma, phloem fibres, crystal fibres and phloem rays. Phloem fibres are aseptate having narrow lumen and rounded to pointed tips. Phloem parenchyma cells are thin walled, rectangular in shape and contain both simple and compound starch grains. Crystal fibres are elongated and divided by transverse partitions into chambers, each chamber contain single, prismatic crystals of calcium oxalate. Phloem rays are mostly 2 - 7 cells wide and 5 - 15 cells high.

The macerated preparation of the bark (Fig.4) under microscope shows aseptate fibre with narrow and wide lumen having pointed to rounded tips; stone cells of varying shape and size, mostly with wide lumen and radiating canals; prismatic crystals of calcium oxalate; crystal fibres 10 - 25 chambered, containing single prismatic crystals of calcium oxalate in each chamber; starch grains simple and compound with 2 - 3 components.

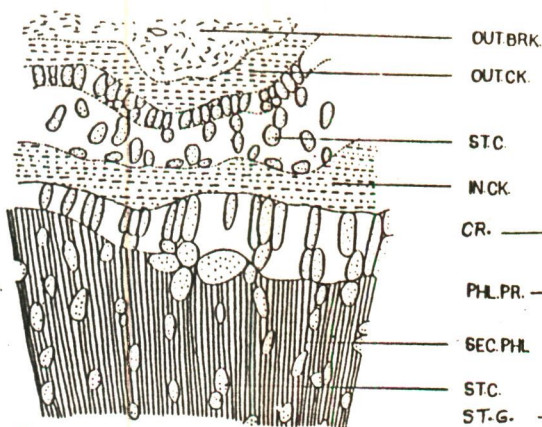


Myrica nagi Thumb.

(PLATE - XIV, FIGS. 4 - 5)

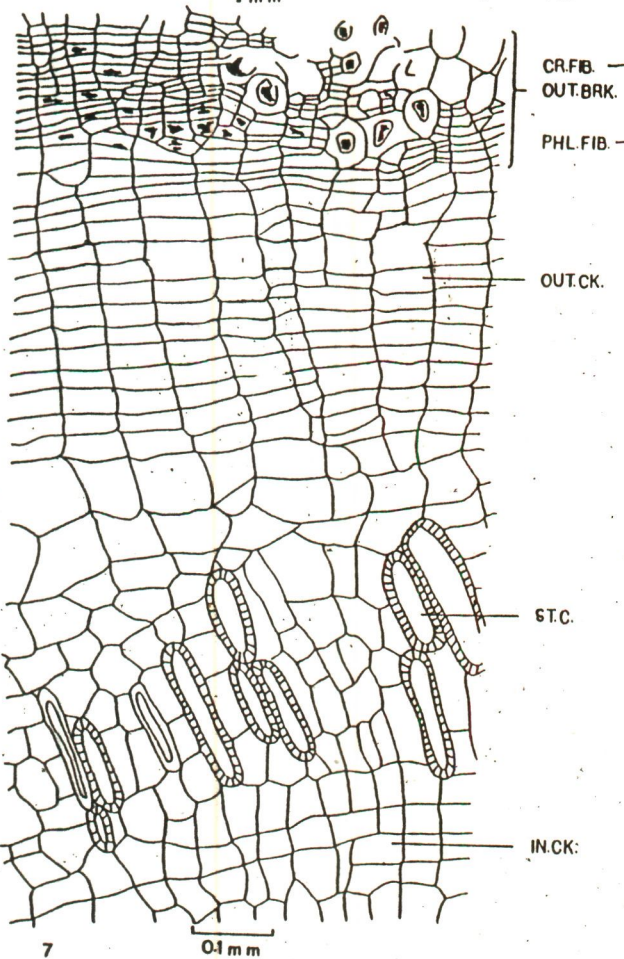
- Fig. 4 : Macerated elements of the bark showing phloem fibres, stone cells, prismatic crystals of calcium oxalate, simple and compound starch grains and crystal fibres.
- Fig. 5 : Powder of the bark showing aseptate phloem fibres with narrow and wide lumen, stone cells, prismatic crystals, starch grains and crystal fibres.

A = Phloem fibre; B = Stone cell;
C = Prismatic crystal of calcium oxalate
D = Crystal fibre; E = Starch grain.



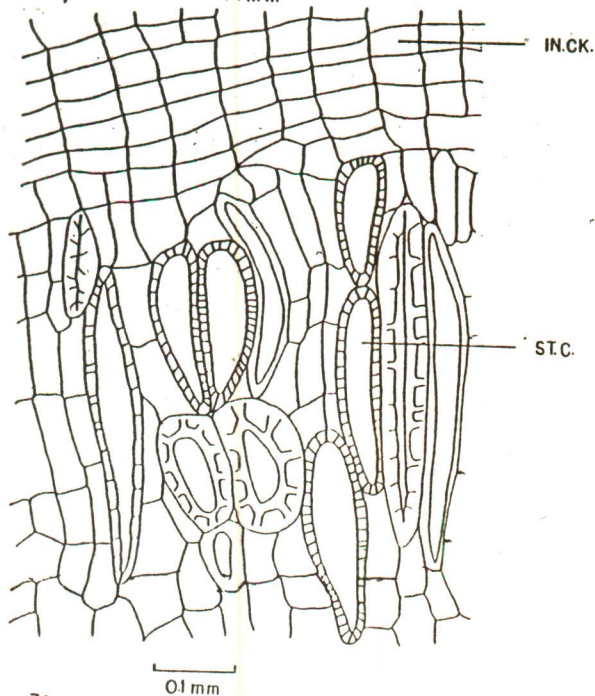
6

1 mm



7

0.1 mm



7A

0.1 mm

OUTBRK.
OUTCK.
STC.
INCK.
CR.
PHL.PR.
SEC.PHL.
STC.
ST.G.
MR.

CR.FIB.
OUTBRK.
PHL.FIB.

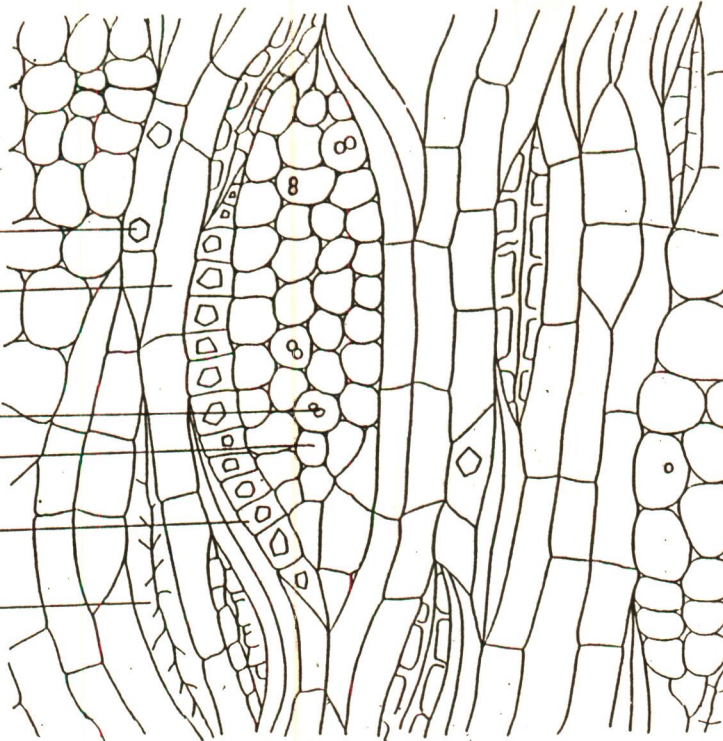
OUTCK.

STC.

INCK.

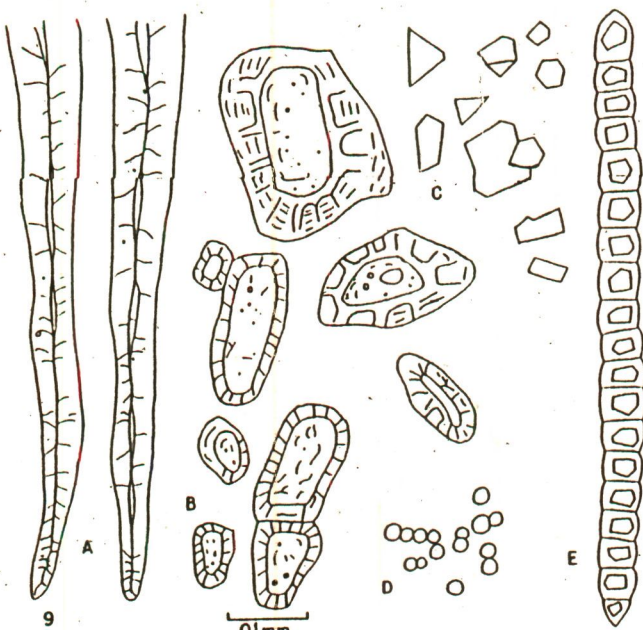
INCK.

STC.



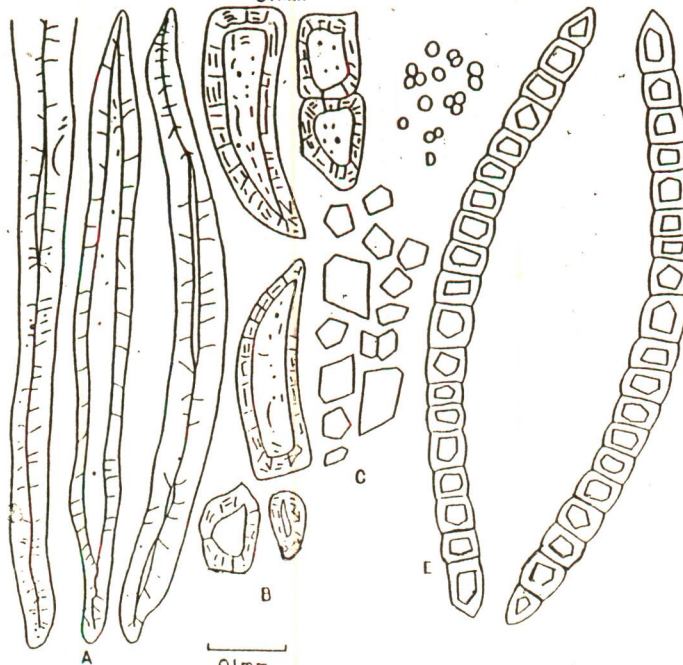
8

0.1 mm



9

0.1 mm



10

0.1 mm

Myrica nagi Thumb.

(PLATE - XV, FIGS. 6 - 10)

- Fig. 6 : T.S. (Diagrammatic) of the thick bark showing the formation of outer bark and the cork, stone cells, inner cork, and secondary phloem.
- Fig. 7 : Details of the T.S. of a portion of the thick bark showing outer bark, outer cork, stone cells, and inner cork.
- Fig. 7A : Details of the T.S. of a portion of the thick bark showing inner cork and stone cells.
- Fig. 8 : Details of the T.L.S. of a portion of thick bark showing phloem parenchyma, medullary ray, phloem fibre, crystal fibre, prismatic crystal and starch grains.
- Fig. 9 : Macerated elements of a portion of the thick bark showing phloem fibres, stone cells, prismatic crystal of calcium oxalate, starch grains, and crystal fibre.
- Fig. 10 : Powder of a portion of the thick bark showing phloem fibres, stone cells, prismatic crystal of calcium oxalate, starch grains, and crystal fibres.

CR., prismatic crystals of calcium oxalate; CR. FIB., crystal fibre; IN. CK., inner cork; MR., medullary ray; OUT. BRK., outer bark; OUT. CK., outer cork; PHL. FIB., phloem fibre; PHL.PR., phloem parenchyma; SEC. PHL., secondary phloem; ST. C., stone cell; ST. G., starch grain.

A = Phloem fibre; B = Stone cell;
C = Prismatic crystal; D = Starch grains;
E = Crystal fibre.

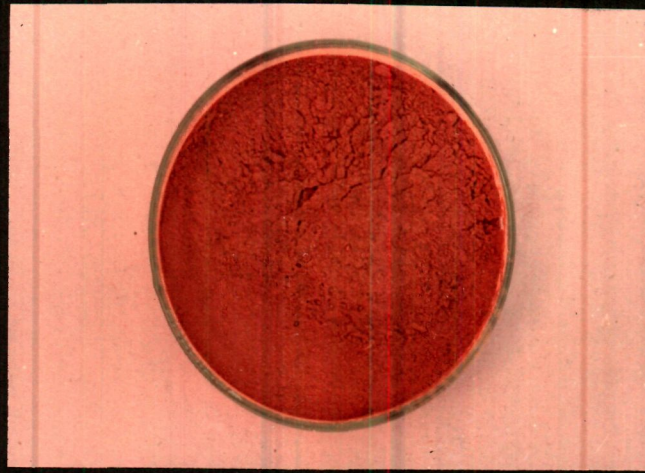


PLATE-XVI

Powder

Cocacola colour (PLATE - XVI); under microscope shows phloem fibres with narrow and wide lumen, stone cells of varying size and shape, prismatic crystals, crystal fibres and starch grains (PLATE - XIV, FIGS. 5 A,B,C,D and E).

Thick bark

The transverse section of mature bark (Fig.7) shows the outer bark consisting of the dead elements of secondary cortex i.e. masses of stone cells interspersed with layers of collapsed, compressed cortical parenchyma and cork cells with brownish colouring matter. Below the outer bark a wide zone of outer cork lies, which consists of tangentially elongated, rectangular, thin-walled cells, followed by secondary cortex composed of oval, rectangular or polygonal, parenchymatous cells of varying size. A number of stone cells either in singles or in groups of 2 - 5 or more of varying shape and size are found scattered in this zone. Majority of the stone cells are elliptical with narrow to wide lumen and radiating canals. Some of the deeper cortical cells show meristematic activity and form the cork cells towards outer side and secondary cortical cells towards the inner side (Fig.7A). This activity is repeated and more cork layers are formed as described under Fig.7A above, only difference being that the stone cells become more prominent and large, depending upon the age of the bark.

The details of the secondary phloem (as shown in Fig.6) has not been drawn as the structure is similar to that of young bark already

described under Fig.2A (thin bark). The only difference being that the phloem becomes more distinct and prominent.

The structure described under T.L.S. of the thin bark at Fig.3 will be the same for the mature bark (Fig.8).

Macerated elements

The description given for thin bark (Fig.4) will also imply for the thick bark (Fig.9).

Powder

The structure shown at Fig.10 has the same detail as those mentioned for the thin bark (Fig.5).

CELL CONTENTS OF THE STEM BARK

Starch grains are present both in thin and thick bark of Katphala. They are distributed throughout the bark, and are simple and compound with mostly 2 - 3 components. The stone cells are present in the secondary cortical cells, singly or in groups of 2 - 3, of different shape and size, arranged radially or longitudinally having radiating canals, some with concentric striations with narrow to wide lumen. The inner cortical region mostly contain stone cells which are elliptical and elongated in shape, single or groups of stone cells are found in secondary phloem region also. Starch grain are also found in most of the phloem parenchyma cells. They are simple to compound, simple grains measuring 3 - 14 μ in diameter. Prismatic crystals of calcium oxalate are present in the phloem parenchyma cells. Ray cells also contain simple and compound starch grains. Crystal fibres with single prismatic crystal of calcium oxalate in each cell are seen present under T.L.S. of the phloem region of the bark. Macerated and the powdered bark shows the presence of starch grains, stone cells, prismatic crystals and crystal fibres. Rosette crystals of calcium oxalate were found absent.

Different solvent extracts of the bark revealed the presence of Sterol, Tannin, Flavonol, and in traces Sugars and Glycosides.

MICROCHEMICAL TESTS

The powder of stem bark was subjected to treatment with different chemical reagents, colour changes and other characteristics noted are given in the following table.

Reagent	Colour change	Inference
Powder + N/50 Iodine (cooled)	No change in colour	Starch absent
Powder + Ferric chloride (5% soln.) + 10% Sodium carbonate	Colour changed to black	Tannin present
Powder + 1 drop Conc. sulphuric acid	No change in colour	Saponin absent
Powder + Conc. Hydrochloric acid	Crystals dissolved	Calcium oxalate present
Powder + Acetic anhydride heated + Sulphuric acid	Turned green blue to violet	Sterol present

Fluorescence Analysis:-

The stem bark powder was examined under ultra violet light according to the method described by Chase and Pratt. The fluorescence characteristics of the stem bark powder seen are given in Table - I.

PHYTOCHEMICAL STUDIES

PRELIMINARY INVESTIGATION

Material used for the investigation:

10 kg. of the stem bark of Katphala (Myrica nagi) was collected from different localities of Nainital and Almora districts for under taking the study. After drying the drug in shade, 5 kg. of the bark drug was powdered in moderately fine form for the extraction.

Determination of percentage extraction:

50 gms. of the powder drug was packed in soxhlet apparatus and successive extraction was done with the following solvents.

- i) Petroleum Ether (60⁰ - 80⁰)
- ii) Solvent ether
- iii) Benzene
- iv) Chloroform
- v) Acetone
- vi) Alcohol
- vii) Distilled Water

Successive extraction was done in each solvent till it exhausted as shown by the disappearance of the colour of the extract through the siphon tube as well as the absence of any residue on evaporation of 5 ml. portion of the extract. After each extraction with one solvent, the drug powder was completely dried in air current before taking the drug for the next extraction in the second solvent of the successive order as given above.

Each extract was filtered and the volume was made to 100 ml. by adding the particular solvent in which the extraction was done. 250 ml. of each extractive was evaporated and the residue was dried to a constant weight in a tared porcelain dish. The percentage extractions of the drug with each solvent were calculated with reference to the air dried drug. The nature, colour (under ordinary/u.v. light) of the extracts and percentage

w/w of extractive values in different solvent are given in Table - II.

Tests of different extracts with various chemicals for plant constituents:

When different extracts of the stem bark powder of Katphala (Myrica nagi) were chemically tested for the presence of various chemical constituents viz. Sterol, Glycoside, Tannin, Alkaloid, Flavonol and Sugar, the extracts gave positive tests for the presence of Sterol, Tannin, Flavonol, while Sugars and Glycosides have been found in traces. The possibility of the presence of Alkaloid was ruled out, as all the chemical tests performed showed the negative results. The results thus obtained by performing various chemical tests are given in Table III.

TABLE - I

Fluorescence characteristics of the stem bark powder
under ultra violet light

Treatment	Fluorescence
Powder as such	Bluish brown
Powder treated with 1N NaOH in methanol	Bluish black
Powder mounted in nitro-cellulose	Bluish black
Powder treated with 1N NaOH in methanol and mounted in nitro-cellulose	Bluish black

TABLE - II

Nature and colour (under ordinary/u.v. light) of extracts alongwith
percentage w/w extractive values in different solvents

S.No.	Solvent	Colour of the extract under ordinary light	Colour of the extract under u.v. light	Nature of the extract	Percentage in w/w of extractives
i)	Petroleum ether (60° - 80°)	Milky white	Colourless with violet tinge	Slightly sticky	1.432
ii)	Benzene	Yellowish brown	Greenish yellow	-do-	1.120
iii)	Solvent ether	Yellowish lemon	Greenish yellow with violet tinge	-do-	0.800
iv)	Chloroform	Light lemon	Greenish yellow with dark violet tinge	-do-	0.480
v)	Acetone	Cocacola red	Blackish red	Sticky	11.680
vi)	Alcohol	Cocacola Red	Bluish black	-do-	33.280
vii)	Distilled Water	Light brown with Milky tinge	Bluish dark brown	-do-	6.720

TABLE - III

Tests performed for different chemical constituents in different extracts

Solvent	Sterol	Alkaloid	Glycoside	Tannin	Flavonol	Reducing Sugars
Petroleum ether (60° - 80°)	+	-	+ in traces	-	-	-
Solvent ether	+	-	+	-	+	-
Benzene	+	-	+ in traces	-	-	-
Chloroform	+	-	-	-	-	-
Acetone	+ in traces	-	+ in traces	+	+	+
Alcohol	+ in traces	-	-	+	+	+
Distilled Water	-	-	-	+	-	+ in traces

DETERMINATION OF ASH CONTENT AND EXTRACTIVE VALUES

Total ash content

Air dried powder drug was accurately weighed in tared silica crucible and incinerated at a low temperature until free from carbon. It was later on heated at a high temperature (400°C - 500°C) to the carbon particles from the residue. The crucible then was cooled in a desiccator and accurately weighed. Three readings were taken and the values were calculated with respect to the air dried weight of the drug.

The total ash and acid insoluble ash content were determined according to the methods given in Pharmacopoeia of India, 1966.

Stem bark

a) Total ash	1.700% w/w
b) Acid insoluble ash	0.166% w/w

Alcohol and water soluble extractives

The alcohol and water soluble extractive values were determined according to the methods given in Pharmacopoeia of India, 1966. The average values thus obtained are as under:-

Stem bark

a) Alcohol soluble extractive	26.920%
b) Water soluble extractive	20.000%

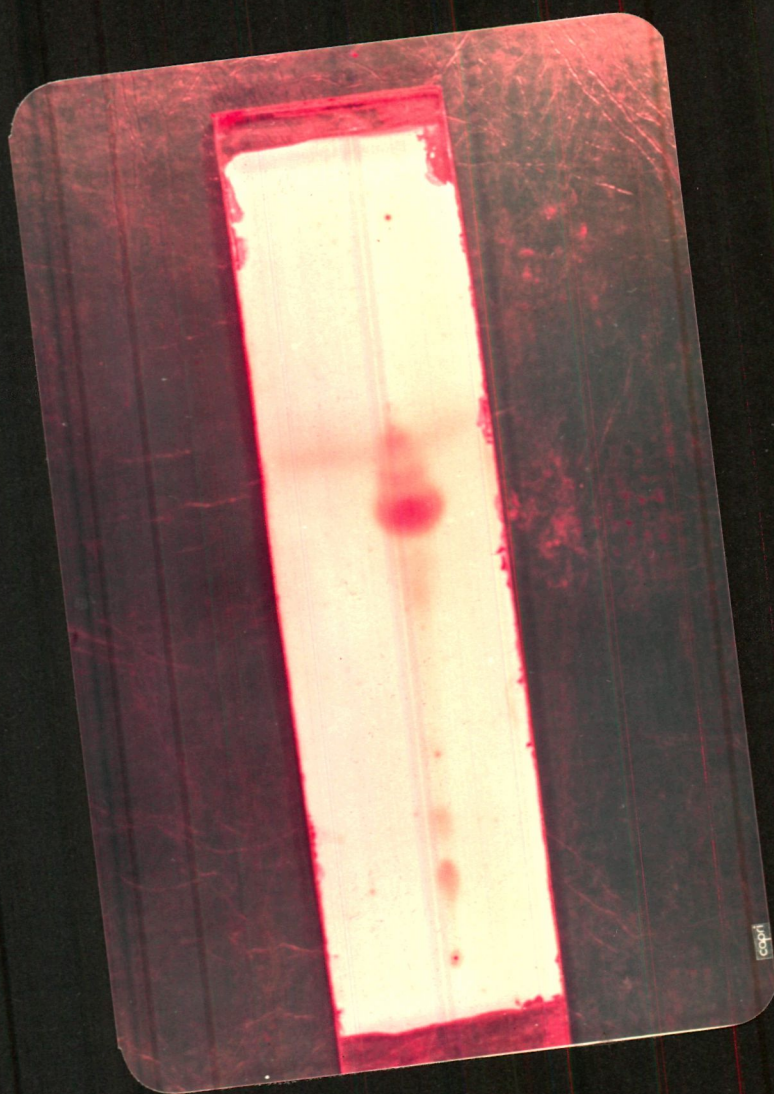


PLATE - XVII A

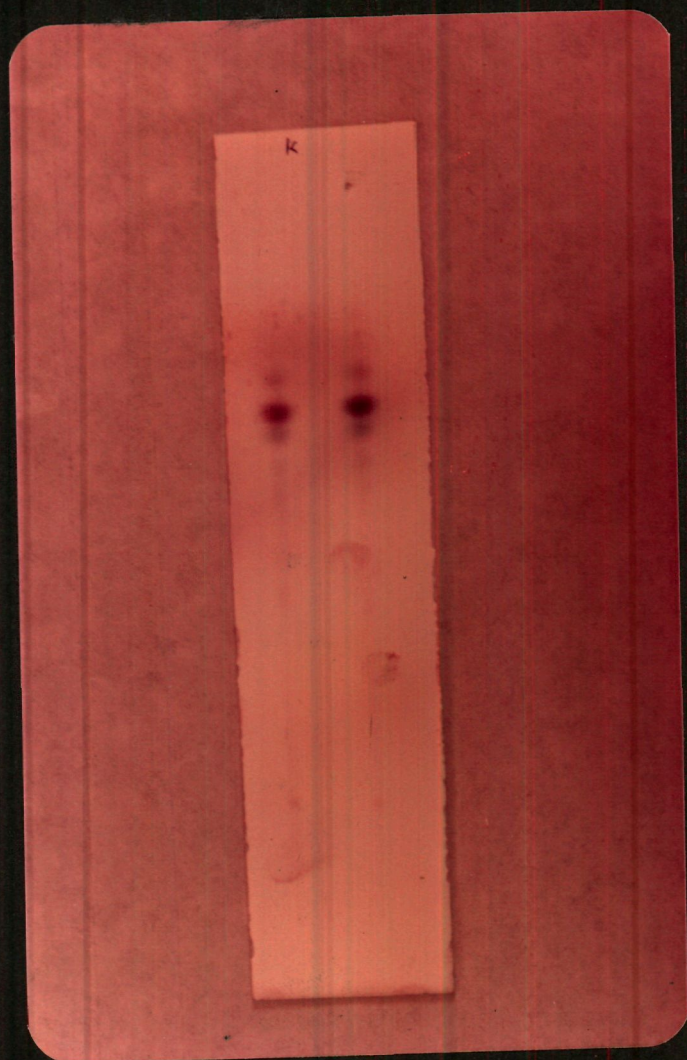


PLATE - XVII

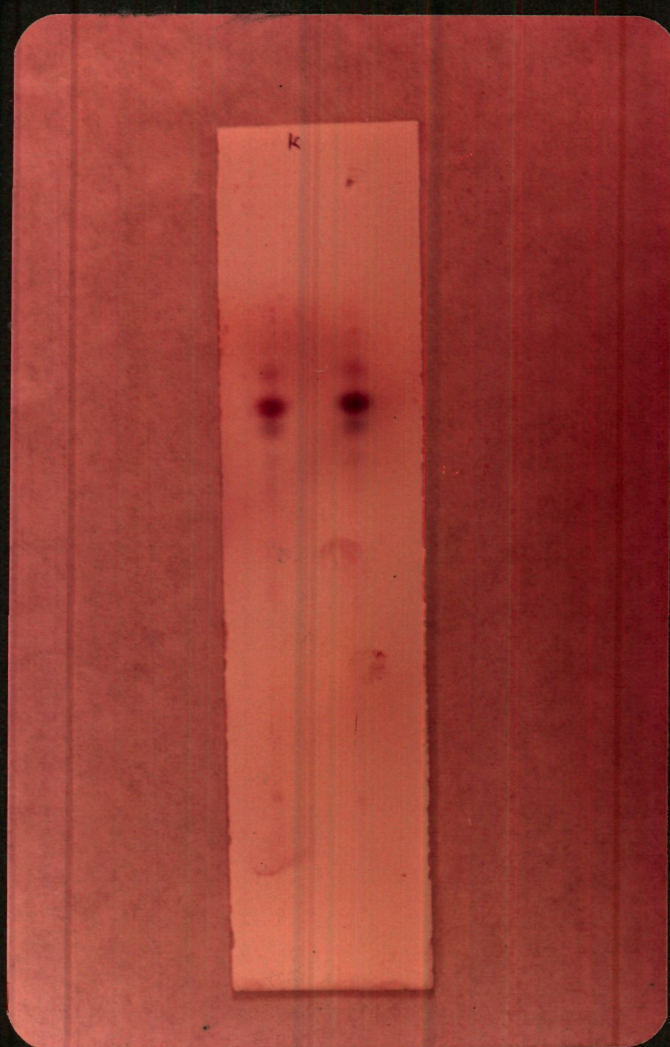


PLATE - XVII

THIN LAYER CHROMATOGRAPHIC STUDIES

For thin layer chromatographic studies of the stem bark of Katphala (Myrica nagi), TLC plate of 20 X 5 cm. was coated with silica gel G and dried for 30 minutes at 110°C.

The chloroform extract was concentrated over water bath to 2 ml. and was spotted on the activated plate and allowed to run in chloroform : methanol (9 : 1) solvent system for a suitable distance. On spraying the plate with anisaldehyde sulphuric acid reagent and heating it at 110°C for about 10 minutes, the following seven spots of different colours appeared (PLATE - XVII).

S.No.	Rf.	Colour
1.	0.181	Pink
2.	0.521	Pink
3.	0.753	Blue
4.	0.804	Blue
5.	0.847	Violet
6.	0.898	Violet
7.	0.949	Violet

PLATE - XVII - A, exposed in iodine chamber showing seven spots at the same Rf. values.

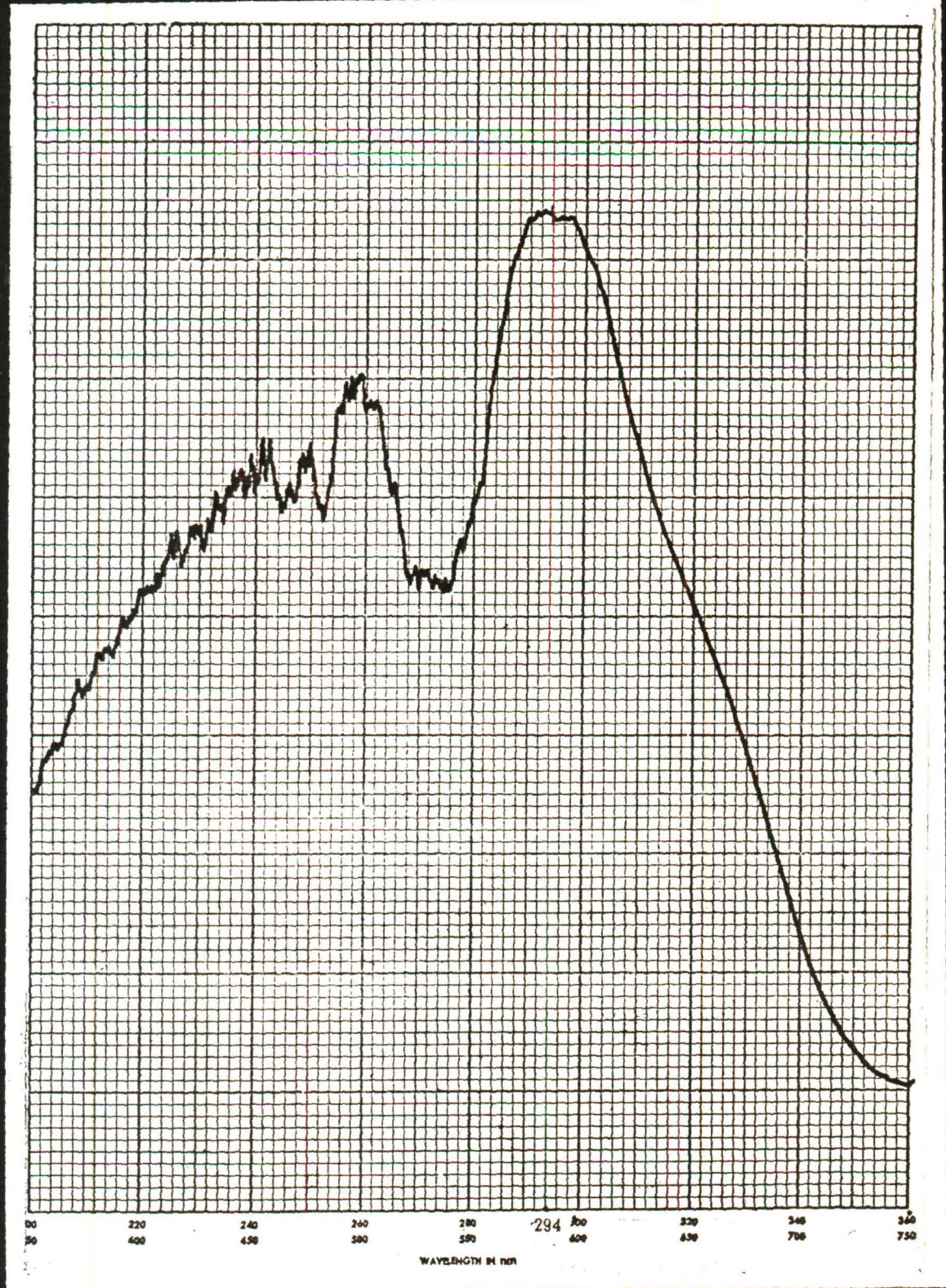


PLATE-XVIII

U.V. SPECTROPHOTOMETRIC STUDIES

The u.v. spectrophotometric studies of Katphala (Myrica nagi) was carried out by diluting the chloroform extract (1 part) in distilled water (99 parts) i.e. in ratio of 1 : 99 and was scanned in u.v. spectrophotometer (360 - 200 n.m.) for the determination of the active constituents. The drug gave a single sharp peak at 294 n.m. (PLATE - XVIII).

S U M M A R Y

The present study deals with the macro-and microscopical and phytochemical studies of Katphala (Myrica nagi). It is a small or moderate sized evergreen tree, and 3 - 15 m. in height. The plant is found in sub-tropical Himalayas at an altitude of 900 - 2,100 m. from Ravi eastward to Lushai hills in the eastern Himalayas.

The fruits of Katphala are edible. They have pleasant, sourish-sweet taste, and used in the preparation of refreshing drink. The bark of the plant is rough, brownish grey having deep vertical wrinkles. Leaves are lanceolate, oblong obovate, crowded towards the end of the branches. They are entire, obtuse, acute or acuminate, sharply serrate, glabrous, with resinous glands beneath, measuring 7.5 - 12.5 mm. by 2.5 - 5 cms. Flowers are minute, unisexual, arranged in axillary male and female spikes. Fruit is a ellipsoid or ovoid drupe of the size of a cherry, tubercled, reddish or cheese coloured when ripe, with rugose nut.

The bark is available both in the form of thin and thick pieces. Thin bark pieces are 0.2 - 0.5 cms. thick, channelled, quilled and light in weight. Externally they are rough, greyish brown, with transversely arranged whitish lenticels, having thin, longitudinal striations. Internal surface is smooth and reddish brown with short fracture. Thick bark pieces are 0.5 - 0.2 cms. in thickness, channelled, and heavy in weight, surface rough externally, having longitudinal and transverse wrinkles, and fracture short, with whitish scars of lichens. It is odourless and astringent in taste.

Transverse section of thin bark shows a wide zone of cork having yellowish brown contents. Secondary cortex is differentiated into three zones. Outer most zone is narrow, having simple as well compound starch

grains. Middle region has simple and compound starch grains, of slightly bigger size, and also has stone cells. They are in single or in groups of different shape and size with radiating canals, some with radiating canals, concentric striations, and narrow to wide lumen. Inner cortical region contains elliptical and elongated compact stone cells. Secondary phloem is composed of phloem parenchyma, phloem fibres and stone cells. Most of the phloem parenchyma cells contain simple to compound starch grains, measuring 3 - 14 μ in diameter of 2 - 3 components. Prismatic crystals of calcium oxalate are present in some of the phloem parenchyma cells. Phloem fibres in groups of 3 - 10 cells, are also present in this region, with thick wall and narrow lumen. Transverse longitudinal section of the secondary phloem region of the bark shows the crystal fibres, aseptate phloem fibres having narrow lumen and narrow to pointed tips. Phloem parenchyma cells contain both simple and compound starch grains. Crystal fibres are elongated and divided by transverse septum into chambers, each containing single prismatic crystal of calcium oxalate. Under microscope the macerated bark shows the presence of aseptate fibres with narrow and wide lumen, stone cells of varying shape, mostly with wide lumen and radiating canals, prismatic crystals of calcium oxalate, 20 - 25 chambered crystal fibres and simple and compound starch grains with 2 - 3 components. The powder of the bark is cocacola coloured, and under microscope shows the same elements as seen under macerated preparation. The transverse section of mature bark shows outer bark with dead elements, masses of stone cells interspersed with compressed cortical parenchyma and cork cells with brownish colouring matter. A wide

zone of outer cork lies below outer bark. Secondary cortex contain a number of stone cells in single or in groups. They are elliptical with narrow to wide lumen and radiating canals. Some of the cortical cells form the cork cells due to meristemisation of the cells towards thin and outer sides of the area. Due to this more cork cells are formed. The details of the secondary phloem are similar as in case of the young bark. Similarly structures under T.L.S., macerated preparation and the powder are same as in young bark, and no differentiating characters have been noted. Under ultra violet light the bark powder when treated with 1N NaOH and mounted in nitro-cellulose shows bluish black fluorescence. The total ash and acid insoluble ash values of the bark have been found to be 1.700% and 0.166% respectively. T.L.C. plate when sprayed with anisaldehyde sulphuric acid reagent and heated at 110°C for 10 minutes showed spots of different colours with the Rf. values - 0.181, 0.521, 0.753, 0.804, 0.847, 0.898 and 0.949. The u.v. spectrophotometric study revealed a single sharp peak at 294 n.m.

CHAPTER - IV

PHARMACOGNOSTICAL AND PHYTOCHEMICAL
STUDIES ON BAKAIN

C. BAKAIN (Melia azedarach Linn.)

INTRODUCTION

Melia azedarach Linn. (Family - Meliaceae), is a medium or moderate sized, deciduous tree reaching a height of 12 m. It is found all over the country and often planted as ornamental tree for its beautiful flowers.

It is known with different names in different parts of the country. Some of the vernacular names of the species are Ghoranim, Mahanim (Beng.); Bakayan, Drek, Mahalimbo, Nimb, Vilayatinim (Bomb.); Bakanlimbodo (Guj.); Bakain, Bakarja, Bakayan, Betain, Deikna, Drek, Mahanimb (Hindi); Are-bevu, Hutchu-bevu, Bevu, Garuda-bevu, Sikka-bevu, Visha-bevu (Kan.); Karin-vembu, Mala-veppu, Sima-veppu (Mal.); Bakananimb, Limbara, Padrai, Pejri, Vilayatinimb (Mar.); Akshadru, Brihannimba, Dreka, Gairika, Giripatra, Himadruma, Kaitarya, Kakanda, Karmuka, Keshamushti, Kshira, Mahadroksha, Mahanimba, Mahatikta, Nimbaka, Parvata, Pavaneshtha, Ramyaka, Sakaleyaka, Shuklasaraka, Vishamushtika (Sansk.); Turaka-vepa, Vetti-vepa (Tel.); Malai-veppam, Pisidam, Sigari nimbam, Tittam (Tam.); Bakayan or Bakain (Urdu).

Bakayan or Bakain (Melia azedarach), Persian Lilac or Bead Tree (English), has long been used by the Arabs and Iranians, who brought the knowledge of its medicinal virtues with them when came to India. They considered the root bark, ^fgruit, flowers and leaves, to be hot and dry, and also described it to be deobstruent, resolvent and alexipharmic in properties. In Unani System, the leaves and flowers are applied as poultice to relieve nervous headache. The juice of the leaves is described to be anthelmintic, antilithic, diuretic and emmenagogue, and is also described to relieve cold swellings and expel the humour which give rise to them. The leaves and seeds are described to be bitter, expectorant, and used

in the enlargement of spleen, and in the heart complaints. The leaves and seeds are also described to be emetic, styptic, stop epistaxis, strengthen the teeth, allay inflammation, cure scabies and dry skin eruptions. The oil from seeds is reported to be brain tonic, laxative, maturent, good for earache, piles, spleen and liver disorders, inflammation and purification of blood. The flowers and leaves are reported to be diuretic, emmenagogue, relieve nervous headache and cold swellings (93). Some of the important formulations of Unani, where the leaves and seeds used as important ingredients, are Araq-e-Musaffi-e-Khoon 'Qawi', Habb-e-Surkh Bada, Raughan-e-Haft-Barg and Tila-e-Musakkin respectively. The bark of Bakain is also used as important ingredient in the formulations like Araq-e-Musaffi-e-Khoon 'Qawi' of Unani System (118).

In Ayurveda the roots of this species are described to be bitter and acrid. It is also reported to be dry, cooling, astringent to the bowels, and used as anthelmintic. It removes 'Kapha' and billiousness, tumours and pain in the heart. It is also reported to be useful in vomiting, leucoderma, belching and in blood impurities. It heals ulcers, headache, uterine pains after delivery and cures fever, burning sensation, urinary discharge, lung complaints and rabbit bite poisoning (93).

Though, various parts of the plant (root bark, leaves, flowers and seeds) are reported to be used to cure various ailments, as mentioned above, but in the classical books of Ayurveda, none of the parts of this species have been mentioned to be used for curing the diseases in any of the formulations given in Ayurvedic Formulary of India (8). However, only the stem bark of this species has been mentioned as one of the

ingredients in the formulations like Brahanmanjithadi-Kwatha-Curna and Mahavisagarbha taila with the name Mahanimba, which is also a name given to Araluka (Ailanthus excelsa), as mentioned in Chapter - II.

The knowledge of the curative properties of this species of the drug yielding plant, as known to Arabs and the Iranians, came down to India through muslim impact. Therefore, it is widely used in Unani System with the name Bakain. In Ayurveda, this drug has very little use probably because it has been taken from Unani System. Like Ayurveda, in Unani also the stem bark is used to a very little extent, as compared to other parts, as mentioned earlier. In Ayurveda, the use of other parts like Unani, is not mentioned in classical texts at all, except the use of stem bark. The name Mahanimba is also used for the drug Araluka (Ailanthus excelsa) and the same names is given to Bakain (Melia azedarach), which is also called Maharukh in Unani.

Because of the controversies, enumerated above, the identification of the drug becomes more difficult, therefore the present study has been under taken in order to provide its exact botanical identity and also to give pharmacognostical and phytochemical data of the drug, as no detailed and elaborate study has so far been made on the stem bark of this species, due to its limited use in Indian System of Medicine (Ayurveda and Unani), though it is described to be official (8,9,118,75).

REVIEW OF THE PREVIOUS WORK

Inspite of the fact that various parts of the plant (Melia azedarach) are described to be used as official drugs in Ayurveda and Unani (8,9,118), but no detailed pharmacognostical and phytochemical work has been done on any of these parts, particularly on the stem bark of Bakain, except the histological work by Iyer et. al. (74-76).

Fruits of the species are reported to contain a poisonous constituent, alkaloid-azaridine, a resin, tannin, meliotannic acid and benzoic acid. Fruits of the plant also yield bakayanin, sterol, a bitter principle margosine and a fixed oil which contains sulphur. It is also reported to contain bakalactone ($C_{22}H_{26}O_4$, m.p. 165 - 215), a liquid product in the heart-wood. Anthelmintic constituents of the cortex give vanillic acid and d,l-catechin. Bark is reported to contain alkaloids azaridine and paraisine (31,201).

PRESENT INVESTIGATION

In the present investigation (Chapter - IV), detailed macro and microscopical studies have been made on the young and mature stem and the mature bark of Bakain (Melia azedarach). Attempts have also been made to study the cell contents, microscopical and the fluorescence characteristics of the mature stem bark. The preliminary phytochemical investigations have also been attempted for determining the percentage of extractives, examination of chemical constituents in respective extractives, total ash contents, and alcohol and water soluble extractives. The powder of the bark drug has also been investigated for TLC (Thin Layer Chromatography). The u.v. spectrophotometric studies have also been undertaken on the bark drug.



PLATE - XIX A



PLATE -XIX B



PLATE-XIX C

Melia azedarach Linn.

(PLATE - XIX)

- A. Whole Plant
- B. Leaves (Close up)
- C. Fruits

EXTERNAL MORPHOLOGY OF THE PLANT

(PLATE - XIX)

The plant is a medium or moderate sized, deciduous tree, attaining a height of about 12 - 15 m., with short trunk covered with dark greyish or greyish brown, shallowly vertically fissured bark, and fairly broad spreading crown, bearing imparibipinnate or occasionally tripinnate leaves, fragrant liliac flowers in many flowered axillary panicles towards the ends of the branches, and small sub-globose, drupaceous fruit, half to three quarters of an inch in length. The young shoots and inflorescence are sparsely clothed with deciduous, stellate hairs (74-76,201). It flowers during March - May and the fruits ripen in the cold season. It yields a soluble gum very similar to that obtained from Neem tree (Azadirachta indica).

The soft wood is yellowish white, and heart-wood red, turning reddish brown with age, mostly straight grained and coarse textured. It is tough, moderately hard and heavy. The tree is lopped for fodder, and the leaves of Bakain, unlike those of Neem, are slightly bitter and are occasionally eaten after boiling with vegetables (93,201).

PHARMACOGNOSTICAL STUDIES

MATERIALS AND METHODS

Samples of the fresh stem and the barks of Bakain (Melia azedarach) were collected from different localities of Ghaziabad and New Delhi, in different stages of growth. The details of the primary structures were studied by cutting the transverse section of the young stem and the mature bark. Market samples of the bark drug were also obtained from different market sources and compared with the authentic specimens.

For microscopical studies free hand, and hand microtomic sections were cut, stained and mounted using the usual plant microtechniques. Microchemical tests for cell contents and cell structures were performed on fresh section as per the methods described by Kay (89), Johansen (81) and Trease (205). Small pieces of the material from different portions were macerated separately in Schultz's fluid, washed with water, teased and mounted in glycerine for the study and measurement of the isolated tissues and cells. The representative diagrams were drawn by using the camera lucida. Powder of the bark drugs were examined under ultra violet light according to the methods given by Chase and Pratt (24).



PLATE - XX

MACROSCOPICAL FEATURES

(PLATE - XX)

Mature bark:

Bark is available in pieces of varying sizes; measuring 0.2 - 1 cm. in thickness depending on the age of the plant. They are brown to greyish brown and curved. External surface rough, longitudinally fissured and exfoliating in small flax. The young pieces of the bark are light brown in colour showing alternate, wavy, tangential bands of light and dark brown colour and lenticels. Internal surface of both young and mature bark pieces are brownish cream to yellowish coloured, slightly rough and fibrous. Fracture is short in outer bark and splintery in inner due to fibrous nature of the bark. There is no characteristic odour and it is slightly bitter in taste.

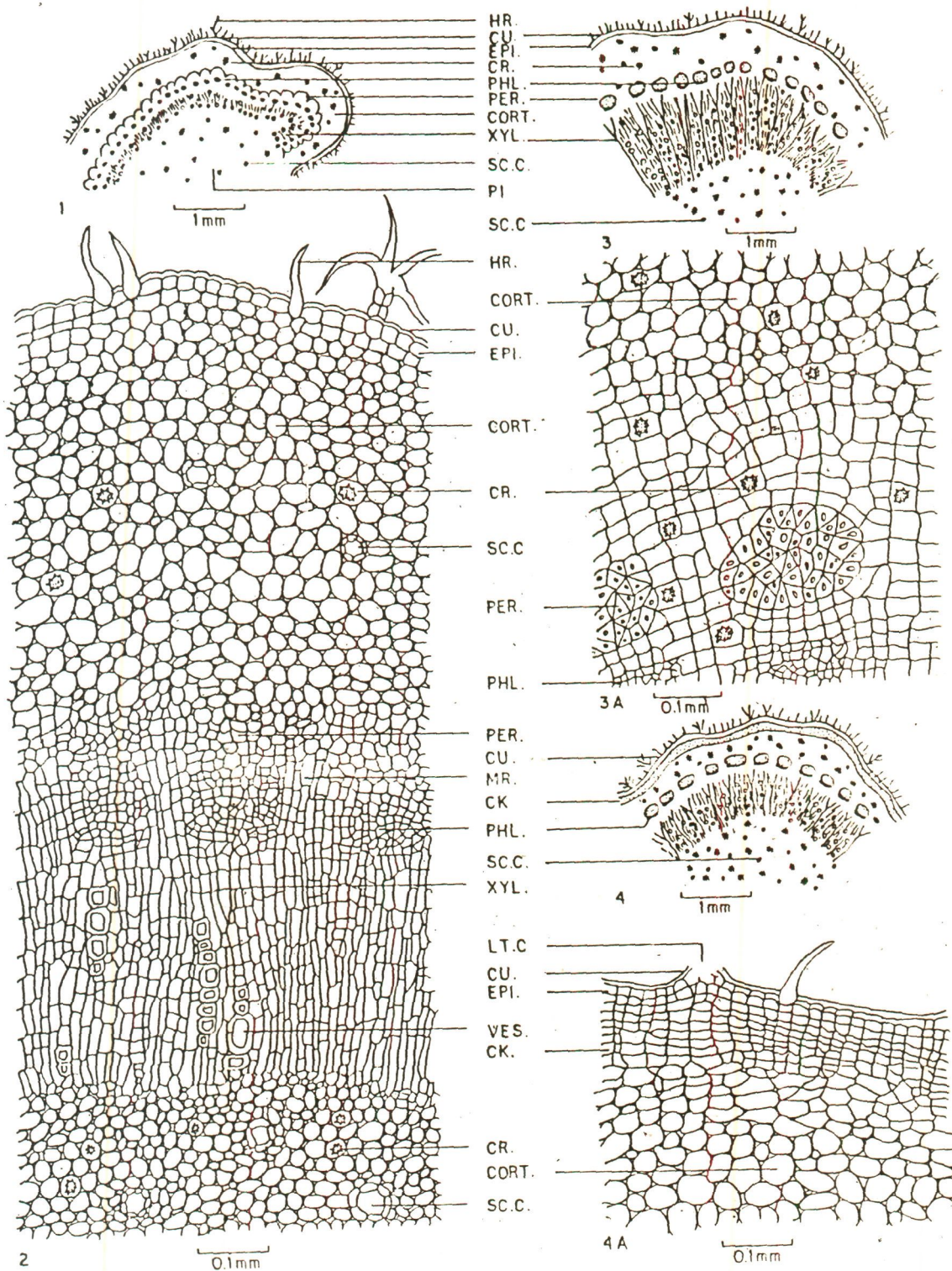


PLATE-XXI

Melia azedarach Linn.

(PLATE - XXI, FIGS. 1 - 4A)

- Fig. 1 : T.S. (Diagrammatic) of young stem showing hair (trichome), endarch vascular bundles with pericycle and rosette crystals.
- Fig. 2 : Details of T.S. of a portion of young stem showing hair, cuticle, epidermis, cortex having crystals and secretory cells.
- Fig. 3 : T.S. (Diagrammatic) of mature stem (early stage) showing pericycle, rosette crystals.
- Fig. 3A : Details of T.S. of the mature stem showing rosette crystals, cortical cells and patches of pericycle.
- Fig. 4 : T.S. (Diagrammatic) of the mature stem (late stage) showing hair, cuticle and the formation of cork.
- Fig. 4A : Details of T.S. of the portion of the mature stem showing lenticel, epidermis and the cork cells.

CK., cork; CORT., cortex; CR., crystal (rosette);
CU., cuticle; EPI., epidermis; HR., hair;
LT. C., lenticel; MR., medullary ray; PER., pericycle;
PI., pith; SC. C., secretory cell; VES., vessel;
XYL., xylem.

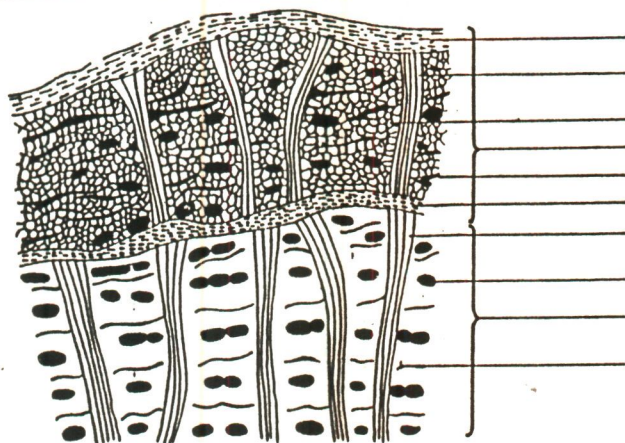
MICROSCOPICAL CHARACTERS

(PLATE - XXI, FIGS. 1 - 4A)

Young stem:

Transverse section of early stage of young stem (Figs.1 & 2) shows single layered epidermis covered by a thin cuticle. The epidermis is composed of cubical to barrel shaped, thin walled cells. Most of the cells of the epidermis elongate to form both unicellular and branched (stellate) hairs. Unicellular hairs are broad at the base and pointed or rounded at tips. The branched hairs are with biseriate, multicellular stalk and long radiating unicellular hairs with pointed tips. The cortex is a wide zone consisting of rounded to oval, thin walled, parenchymatous cells with smaller intercellular spaces. Cells of outer 2 - 3 layers are smaller in size, and slightly tangentially elongated. In the cortical zone some secretory cells are found scattered. Some of the cells throughout the cortical zone contain rosette crystals of calcium oxalate. The early stage of young stem (Fig.2) shows the initiation of the pericyclic fibres and the phloem fibres, traversed by medullary rays. The xylem forms a wide zone with the initiation of xylem vessels which are arranged radially. The xylem parenchyma consisting of radially arranged thin walled cells. The pith is a very wide zone consisting of thin walled, rounded to oval cells with intercellular spaces. Some of these cells contain rosette crystals of calcium oxalate. Secretory cells are also found present in this region.

Transverse section of the late stage of young stem (Figs.3 & 3A) shows similar characters for the hairs, cortex, secretory cells and rosette crystals of calcium oxalate to those of young stem (Fig.2). Major differences in the late stage of the young stem is being the complete



5

1mm

CK.
MR.
PHL.FIB.
PHL.PR.
RHM.
CER.
CK.
MR.
PHL.FIB.
SEC.PHL.
JER.
CR.FIB.

PHL.PR.
ST.GR.

CK.
CR.
PHL.PR.
CER.

CR.
RHM.
R.PR.
PHL.FIB.

IN.CK.

PHL.PR.

ST.GR.

CER.
SEC.PHL.

CR.

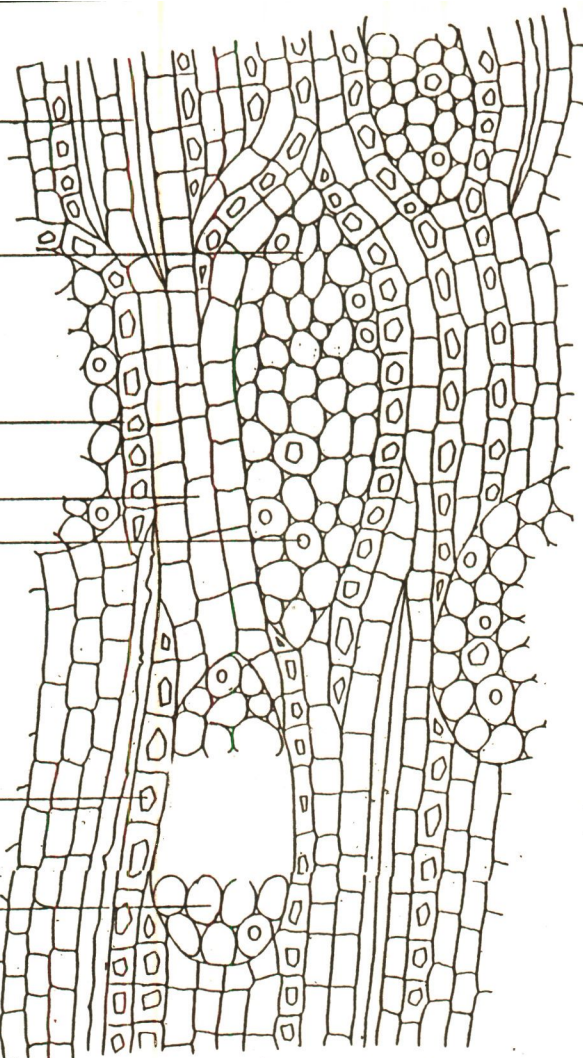
PHL.FIB.

CR.

PHL.PR.

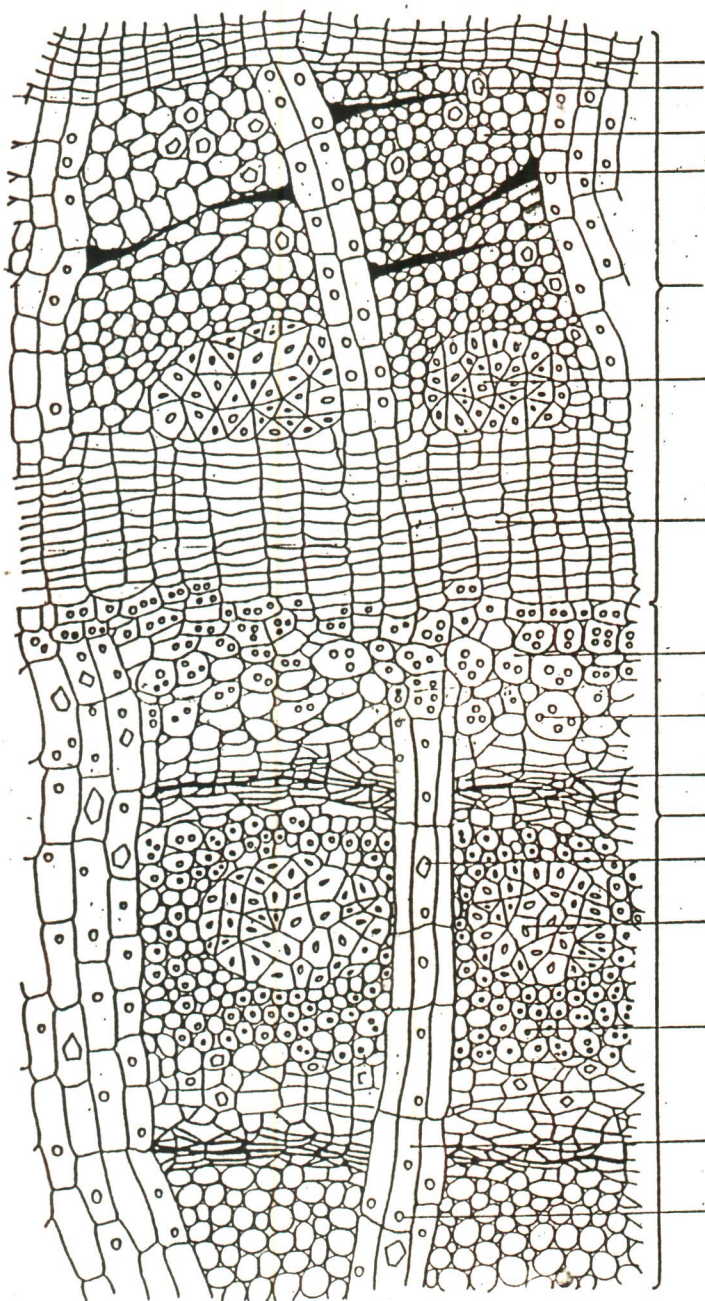
MR.

CR.FIB.
ST.GR.



7

0.1mm



6

0.1mm

PHL.PR.

ST.GR.

CER.
SEC.PHL.

CR.

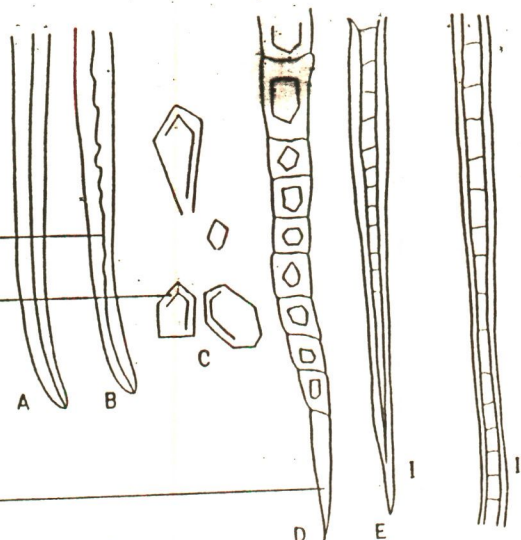
PHL.FIB.

CR.

PHL.PR.

MR.

CR.FIB.
ST.GR.



8

0.1mm

Melia azedarach Linn.

(PLATE - XXII, FIGS. 5 - 8)

- Fig. 5 : T.S. (Diagrammatic) of mature bark showing rhytidoma, cork, medullary rays, phloem parenchyma, ceratenchyma, and inner cork.
- Fig. 6 : Details of T.S. of a portion of mature bark showing outer and inner cork, ceratenchyma, patches of phloem fibre, prismatic crystals, starch grains, medullary rays and the formation of rhytidoma.
- Fig. 7 : Details of T.L.S. of a portion of the mature bark, showing phloem fibres, medullary rays, phloem parenchyma, starch grains and prismatic crystals, ray parenchyma and crystal fibres.
- Fig. 8 : Powder of the mature bark showing phloem fibres, prismatic crystals and crystal fibres.

CER., ceratenchyma; CK., cork; CR., crystal (rosette);
CR. FIB., crystal fibre; IN. CK., inner cork;
MR., medullary ray; PHL. FIB., phloem fibre;
PHL. PR., phloem parenchyma; RHM., rhytidoma;
R. PR., ray parenchyma; SEC. PHL., secondary
phloem; ST. GR., starch grain.

A & B = Aseptate phloem fibre;
C = Prismatic crystal;
D = Crystal fibre;
E I & II = Septate phloem fibre.

formation of the pericyclic fibre patches, distinct phloem patches and the differentiation of the cortical cells, becoming tangentially elongated, radially arranged and thin walled, around the pericyclic fibre patches.

Mature stem:

Transverse section of mature stem (Fig.4 & 4A) shows 8 - 10 layers of tangentially elongated and radially arranged cork cells. At places the epidermal layer along with cuticle and few outer layers of cork cells disintegrate and lenticels are formed. The secondary cortex is composed of oval to elliptical, tangentially elongated and thin walled, parenchymatous cells with conspicuous intercellular spaces.

Mature bark:

Transverse section of the mature bark (Fig.5 & 6) shows formation of rhytidoma composed of alternating strips of cork tissues and secondary phloem patches which are dark brown in colour. Each strip of cork is many layered consisting of thin walled, tangentially elongated, rectangular cells. The phloem fibre patches are mostly surrounded by numerous collapsed phloem parenchyma cells, few of them containing prismatic crystals of calcium oxalate, and traversed by medullary rays, having simple starch grains. Some of the phloem parenchyma cells get crushed and form the ceratenchyma bands distributed throughout this region.

The secondary phloem is composed of sieve elements, phloem parenchyma and phloem fibres, traversed by phloem rays. Phloem parenchyma is composed of rounded to oval, thin walled cells, mostly containing simple starch grains, few of the layers of phloem parenchyma

cells towards the cork are larger in size. The phloem fibres are arranged in groups of alternating patches. They are thick walled, lignified, tetra to hexagonal with narrow lumen, mostly present in between the medullary rays or attached to medullary rays. Phloem fibres are present in groups of 20 - 35 cells. The phloem fibre patches are surrounded by smaller cells of phloem parenchyma, mostly containing simple starch grains. In between the phloem fibre patches some of the phloem parenchyma cells show the initiation of ceratenchyma. Medullary rays are 3 - 7 cells wide, wavy, radially arranged, ending at the cork strips. Most of the ray cells contain simple starch grains and few prismatic crystals of calcium oxalate. Few of the phloem parenchyma cells near ceratenchyma have prismatic crystals of calcium oxalate. Medullary rays in between the two phloem fibre patches some times get narrowed, due to the pressing of the phloem fibre patches.

Transverse longitudinal section (TLS) of the secondary phloem region of the bark (Fig.7) shows the presence of phloem parenchyma, phloem fibres, medullary rays and crystal fibres. A few starch grains and prismatic crystals of calcium oxalate are also seen present in the medullary rays. The phloem fibres are thin walled with narrow lumen and have rounded tips. Medullary rays are 3 - 7 cells wide consisting of rounded to oval cells having few simple, rounded to oval starch grains and prismatic crystals of calcium oxalate.

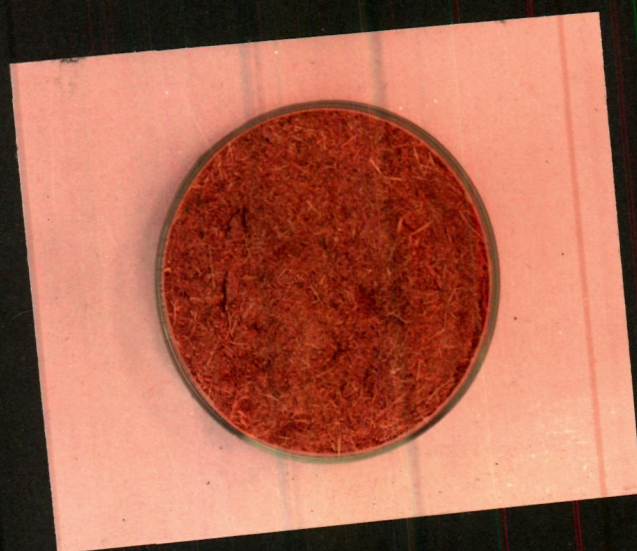


PLATE-XXIII

Powder:

Reddish brown (PLATE - XXIII), under microscope the bark powder shows both aseptate (Fig.8A & B) and septate (Fig.8E - I & II) fibres, prismatic crystals of calcium oxalate (Fig.8C) and septate crystal fibres (Fig.8D). The aseptate phloem fibres are thin walled having narrow lumen with slightly rounded tips. The septate phloem fibres are thick walled with wide lumen and pointed tips. The prismatic crystals of calcium oxalate are tetra to hexagonal in shape and of varying size.

CELL CONTENTS OF STEM AND STEM BARK

The rosette crystals of calcium oxalate are found distributed in the cortical and pith cells of the young stem (early and late stage), and the mature stem. In the mature bark few of the phloem parenchyma cells contain prismatic crystals of calcium oxalate, and the medullary rays contain starch grains. In the secondary phloem region of the mature bark phloem parenchyma cells mostly contain only simple starch grains, while ray cells mostly contain starch grains and few prismatic crystals of calcium oxalate. Under T.L.S. the crystal fibres are seen present in the secondary phloem region of the mature bark. Few starch grains and prismatic crystals of calcium oxalate are also present in the medullary cells. The starch grains are simple, rounded to oval and the prismatic crystals of calcium oxalate are tetra to hexagonal in shape and of varying size.

The chloroform and the alcoholic extract of the bark revealed the presence of sterol, alkaloid, tannins and reducing sugars, in addition to the above cell contents.

MICROCHEMICAL TESTS

The powder of stem bark was subjected to treatment with different chemical reagents, colour changes and other characteristics noted are given in the following table.

Reagent	Colour change	Inference
Powder + N/50 Iodine	Turned blue	Starch present
Powder + Ferric chloride (5% soln.) + 10% Sodium carbonate	Colour changes to black	Tannin present
Powder + 1 drop Conc. sulphuric acid	No change in colour	Saponin absent
Powder + Conc. Hydrochloric acid	Crystals dissolved	Calcium oxalate present
Powder + Acetic anhydride heated + Sulphuric acid	Turned blue	Sterol present

Fluorescence Analysis:-

The stem bark powder was examined under ultra violet light according to the method described by Chase and Pratt. The fluorescence characteristics of the stem bark powder seen are given in Table - I.

PHYTOCHEMICAL STUDIES

PRELIMINARY INVESTIGATIONS

Material used for the investigation

10 kg. of the stem bark of Bakain (Melia azedarach) was collected locally and from different localities of New Delhi for under taking the study. After drying in shade, 1 kg. of the bark drug was powdered in moderately fine form for the extraction.

Determination of percentage extraction

50 gms. of the powder drug was packed in soxhlet apparatus and successive extraction was done with the following solvents.

- i) Petroleum Ether (60⁰ - 80⁰)
- ii) Solvent ether
- iii) Benzene
- iv) Chloroform
- v) Acetone
- vi) Alcohol
- vii) Distilled Water

Successive extraction was done in each solvent till it exhausted as shown by the disappearance of the colour of the extract through the siphon tube as well as the absence of any residue on evaporation of 5 ml. portion of the extract. After each extraction with one solvent, the drug powder was completely dried in air current before taking the drug for the next extraction in the second solvent of the successive order as given above.

Each extract was filtered and the volume was made to 100 ml. by adding the particular solvent in which the extraction was done. 25 ml. of each extractive were evaporated and the residue was dried to a constant weight in a tared porcelain dish. The percentage extractions of the drug with each solvent were calculated with reference to the air dried drug. The nature, colour (under ordinary/u.v. light) of the extracts and

percentage w/w of extractive values in different solvents are given in Table II.

Tests of different extracts with various chemicals for plant constituents

When different extracts of the stem bark powder of Bakain (Melia azedarach) were chemically tested for the presence of various chemical constituents viz. Sterol, Alkaloid, Glycoside, Tannin, Flavonol and Sugar, the extracts gave positive tests for the presence of Sterol, Alkaloid, Tannin and Sugars. The possibility of the presence of Glycoside and Flavonol was ruled out, as all the chemical tests performed showed the negative results. The results thus obtained by performing various chemical tests are given in Table III.

TABLE - I

Fluorescence characteristics of the stem bark powder
under ultra violet light

Treatment	Fluorescence
Powder as such	Colourless with violet tinge
Powder treated with 1N NaOH in methanol	Greenish yellow
Powder mounted in nitro-cellulose	Light greenish yellow
Powder treated with 1N NaOH in methanol and mounted in nitro-cellulose	Dark brown

TABLE - II

Nature and colour (under ordinary/u.v. light) of extracts alongwith percentage w/w extractive values in different solvents

S.No.	Solvent	Colour of the extract under ordinary light	Colour of the extract under u.v. light	Nature of the extract	Percentage in w/w of extractives
i)	Petroleum ether (60° - 80°)	Milky white	Milky white	Normal	2.480
ii)	Benzene	Milky white with yellow tinge	Greenish white	-do-	1.080
iii)	Solvent ether	Colourless	Greenish white with violet tinge	-do-	0.080
iv)	Chloroform	Faint yellow	Greenish white with yellowish tinge	-do-	0.800
v)	Acetone	Cocacola red	Blackish red with greenish tinge	-do-	4.000
vi)	Alcohol	Cocacola red	Blackish red with greenish tinge	Slightly sticky	5.600
vii)	Distilled Water	Dull brown	Blackish red with greenish tinge	Normal	5.010

TABLE - III

Tests performed for different chemical constituents in different extracts

Solvent	Sterol	Alkaloid	Glycoside	Tannin	Flavonol	Reducing Sugars
Petroleum ether (60° - 80°)	+	-	-	-	-	-
	in traces					
Solvent ether	+	-	-	-	-	-
	in traces					
Benzene	+	-	-	-	-	-
	in traces					
Chloroform	+	+	-	+	-	-
Acetone	+	-	-	-	-	-
Alcohol	+	+	-	+	-	+
Distilled Water	+	-	-	+	-	+
						in traces

DETERMINATION OF ASH CONTENT AND EXTRACTIVE VALUES

Total ash content

Air dried powder drug was accurately weighed in tared silica crucible and incinerated at a low temperature until free from carbon. It was later on heated at a high temperature (400°C - 500°C) to the carbon particles from the residue. The crucible then was cooled in a desiccator and accurately weighed. Three readings were taken and the values were calculated with respect to the air dried weight of the drug.

The total ash and acid insoluble ash content were determined according to the methods given in Pharmacopoeia of India, 1966.

Stem bark

- | | |
|-----------------------|------------|
| a) Total ash | 8.517% w/w |
| b) Acid insoluble ash | 0.750% w/w |

Alcohol and water soluble extractives

The alcohol and water soluble extractive values were determined according to the methods given in Pharmacopoeia of India, 1966. The average values thus obtained are as under:-

Stem bark

- | | |
|-------------------------------|---------|
| a) Alcohol soluble extractive | 10.130% |
| b) Water soluble extractive | 5.301% |

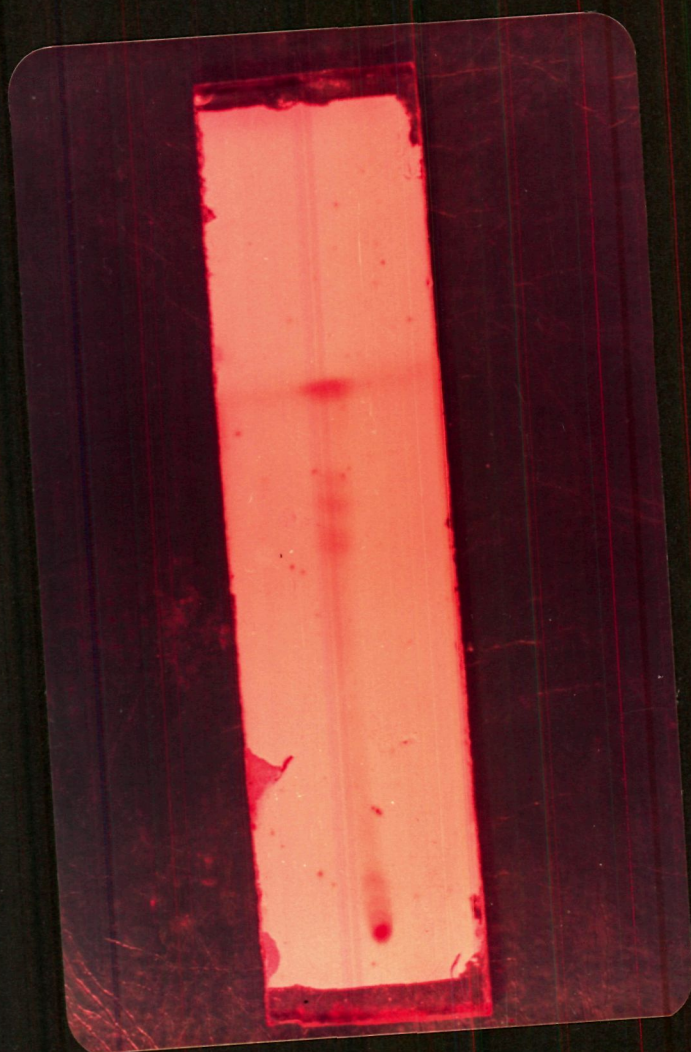


PLATE-XXIV

THIN LAYER CHROMATOGRAPHIC STUDIES

For thin layer chromatographic studies of the stem bark of Bakain (Melia azedarach), TLC plate of 20 X 5 cm. was coated with silica gel G and dried for 30 minutes at 110°C.

The chloroform extract was concentrated over water bath to 2 ml. and was spotted on the activated plate and allowed to run in chloroform : methanol (9 : 1) solvent system for a suitable distance. When the plate was observed in u.v. light only two spots appeared. Both the spots were of blue colour.

Bakain in u.v.

S.No.	Rf.	Colour
1.	0.341	Blue
2.	0.780	Blue

When the same plate was kept in iodine chamber for ten minutes, five spots at the following Rf. values were observed (PLATE - XXIV).

S.No.	Rf.
1.	0.221
2.	0.260
3.	0.372
4.	0.851
5.	0.967

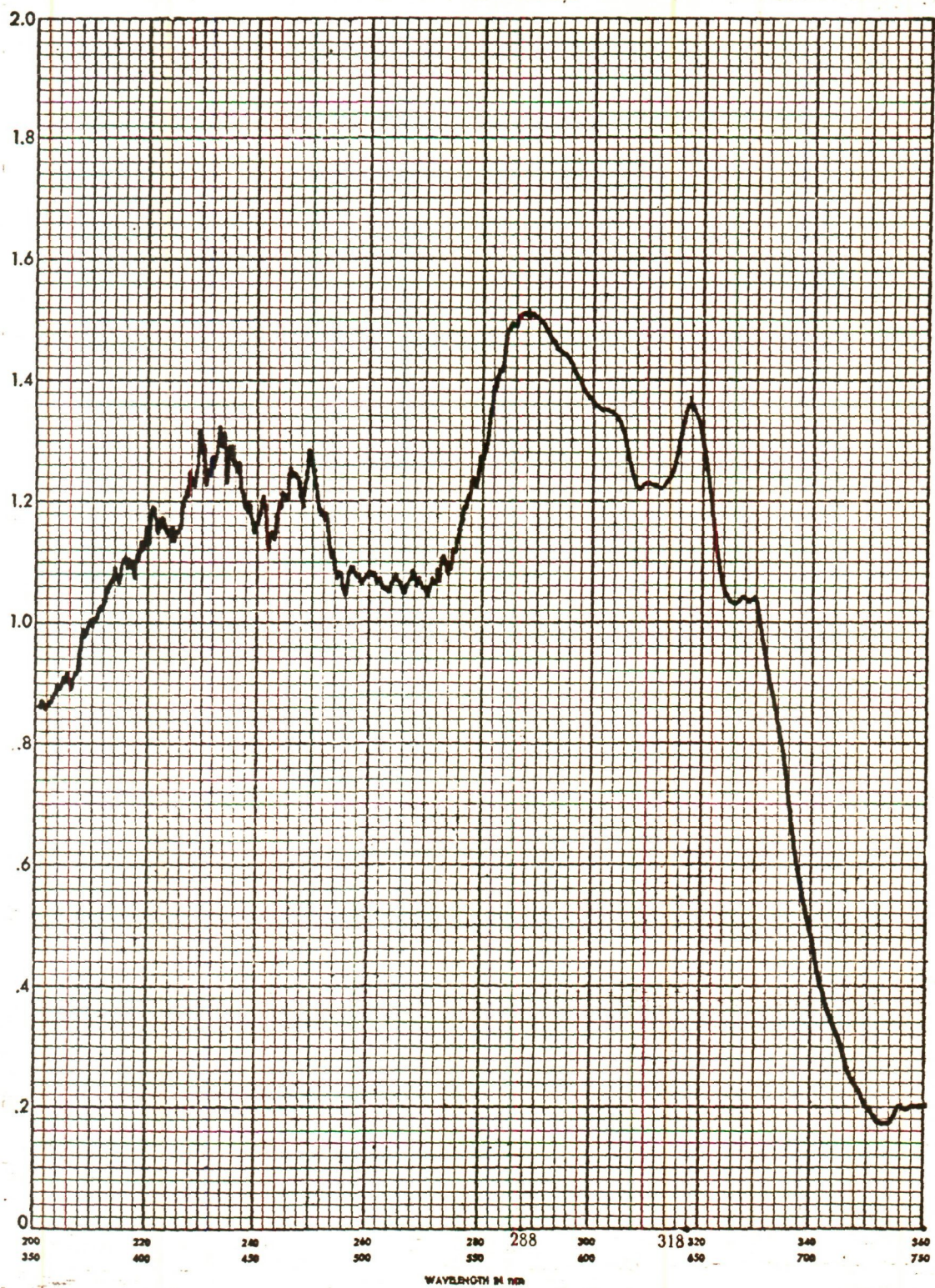


PLATE-XXV

U.V. SPECTROPHOTOMETRIC STUDIES

The u.v. spectrophotometric studies of Bakain (Melia azedarach) was carried out by diluting the chloroform extract (1 part) in chloroform (99 parts) i.e. in ratio of 1 : 99, and was scanned in u.v. spectrophotometer (360 - 200 n.m.) for the determination of the active constituents. Two prominent peaks appeared in the u.v. region, one at 288 n.m. and the other at 318 n.m. (PLATE -XXV).

EXTRACTION OF THE DRUG FOR ISOLATION AND CHARACTERISATION

OF STEROLS

Extraction

5 kg. of the powdered drug was moistened with alcohol (95%) and packed in a Soxhlet apparatus. The extraction was done with ammoniacal alcohol (95%) till the complete extraction was ensured. The extract was filtered and most of the solvent was removed from the filtrate by distillation under reduced pressure.

Isolation

The concentrated mass left after distillation under reduced pressure was transferred to a flask with the help of alcoholic potash and was saponified by refluxing with (300 ml.) of 2N alcoholic potassium hydroxide solution. After saponification the solvent was distilled off under reduced pressure. The residue was diluted with water and extracted repeatedly with chloroform till it gave positive test for the presence of sterols. The chloroform extracts were mixed and washed with distilled water till the aqueous washings were neutral to a solution of phenolphthalein. The chloroform extract was dried over anhydrous sodium sulphate for 24 hours, and then filtered off. The solvent was then distilled off under reduced pressure. The crude concentrate thus obtained was subjected to column chromatography over silica gel.

Preparation of the column

About 200 gms. of the silica gel was taken in a crucible, heated to 110°C for one hour, and it was then cooled in a desiccator.

The packing of the column was effected by making the slurry of the silica gel with benzene and putting directly into the absorption tube upto a height of 75 cm., draining the excess of the solvent through the nozzle of the tube.

Development of the column

The sample in the concentrated form was transferred to the top of the column and allowed to drain down the column at a rate of about 4 to 5 drops per minute.

Elution of the column

Subsequently the column was eluted first with benzene. The eluates were collected in 20 ml. fractions in numbered flasks. After first two fractions, a white crystalline compound started crystallising at the nozzle of the column. Fraction 3 to 14 when subjected to thin layer chromatography, taking petroleum ether, benzene (9 : 1) as the solvent system, showed a single spot at the same Rf. value (0.216).

The observations noted during the collection of the first compound, which showed the positive test for sterols, are given in Table - IV. All the fractions from 3 to 14 when evaporated separately gave the residue having nearly the same melting point and represented a single sterol in thin layer chromatography. All these fractions were collected together and were concentrated and kept for crystallisation in refrigerator. A white crystalline compound appeared after keeping the concentrate in

TABLE - IV

No. of fraction	Solvent used	Volume of each fraction	Rf.
1	Benzene	20 ml.	-
2	-do-	-do-	-
3	-do-	-do-	0.215
4	-do-	-do-	0.215
5	-do-	-do-	0.216
6	-do-	-do-	0.215
7	-do-	-do-	0.215
8	-do-	-do-	0.215
9	-do-	-do-	0.216
10	-do-	-do-	0.215
11	-do-	-do-	0.215
12	-do-	-do-	0.215
13	-do-	-do-	0.215
14	-do-	-do-	0.216

refrigerator for one hour, this was labelled as Sterol 'A'. The m.p. of this compound was found to be 159°C . The mother liquor on further concentration did not give any more crystals.

Same observations were also noted for the fractions collected in benzene : chloroform (9 : 1) as the solvent system. Fractions 18 to 23 (TABLE - V) having the same Rf. values (0.188) were mixed together, concentrated and were kept for crystallisation in a refrigerator. The crystalline product obtained was labelled as Sterol 'B', having m.p. at 135°C . The solvent in the column was changed from chloroform to methanol. But, all the collected fractions showed a negative response to the test for sterols.

CHARACTERISATION OF THE ISOLATED STEROLS

Preparation of derivative

Digitonide derivative:- Digitonin has proved particularly useful in the field of steroidal chemistry, where it forms insoluble complexes which are readily isolated with those steroids that have $\text{C}_3\text{-OH}$ i.e., normal OH group. Those in which $\text{C}_3(\text{OH})$ is in epiform complex forms are soluble in alcohol. Thus a two fold usefulness is achieved i.e., determination of configuration about $\text{C}_3\text{-OH}$ and a means of purification, because these complexes can be resolved readily into respective components.

Digitonide derivative of the isolated sterols were separately prepared for each sterol and the procedure followed for its preparation is as given herewith.

TABLE - V

No. of fractions	Solvent used	Volume of each fraction	Rf.
18	Benzene : Chloroform 9 : 1	20 ml.	0.188
19	-do-	-do-	0.188
20	-do-	-do-	0.188
21	-do-	-do-	0.188
22	-do-	-do-	0.188
23	-do-	-do-	0.188

5 mg. of the sample was dissolved in 5 ml. of alcohol by warming on a water bath. 5 ml. of 0.5% solution (w/w) of digitonin in alcohol was prepared by warming. Both, the alcoholic solutions were mixed and warmed on a water bath at 60° - 70°C for one hour. The time of formation of the precipitate was recorded. The precipitate thus formed was removed by filtration, washed with alcohol to remove adherent impurities and dried in a vacuum desiccator. The m.p. of the derivatives were determined. It was found that the melting points of the digitonide were a little bit higher than those of the melting points of the corresponding sterols. It was further observed that both sterols 'A' & 'B' formed digitonide immediately.

Comparative study of Sterols (A & B) and their corresponding Digitonide

Sterol	Shape of crystals 'Sterol'	Shape of crystals 'Digitonide'	M.P. Sterols	M.P. Digitonides
A	Flakes	Flakes	159°C	180°C
B	Granules	Flakes	135°C	165°C

Test for elements

The test for Nitrogen, Halogens and Sulphur were carried out by the usual methods* for both the sterols and were found to be absent in both the cases.

*

- i) Cheronis, N.D., and J.B. Entrikin, 1957, Semimicro Qualitative Organic Analysis, Interscience Publishers Ltd., London.
- ii) Clarke, H.T., 1956, A Hand Book of Organic Analysis, Edward Arnold Ltd., London, 9, 91.

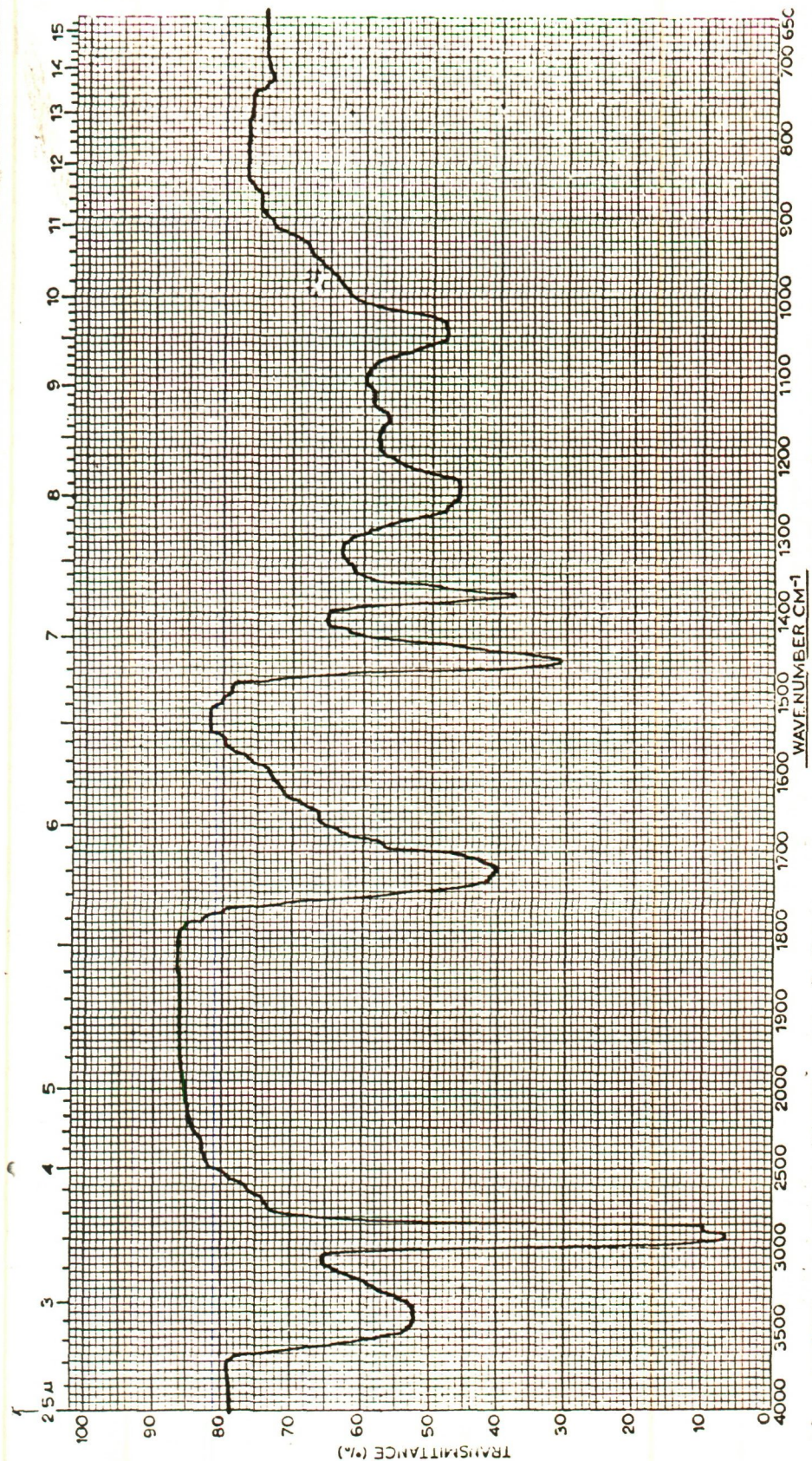


PLATE -XXVI

Estimation of elements

Sterol 'A' melting point 159°C .

The percentage of Carbon, Hydrogen and Oxygen was found to be

C, 81.5

H, 11.6

O, 4.0

Therefore, the empirical formula is $\text{C}_{27}\text{H}_{45}\text{O}$

The empirical weight = 385

Infra Red Spectrum Studies

To get an idea about the various groupings present in the molecule, the compound was subjected to Infra Red Spectral analysis. Potassium bromide pellet was used with the concentration of the compound as 2 mg/200 mg. of KBr. Different peaks corresponding to the various groupings were obtained (PLATE - XXVI) and tabulated as given in TABLE - VI.

TABLE - VI

Absorption bands Cm. ⁻¹	Assigned groupings
3400	Free O-H stretching vibrations
2900	Alkane $\begin{array}{c} \text{H} \\ \diagup \\ \text{-C} \\ \diagdown \\ \text{H} \end{array}$ stretching
2810	-CH ₂
1460	-CH ₃
1380	$\begin{array}{c} \text{CH}_3 \\ \diagup \\ \text{-H-C} \\ \diagdown \\ \text{CH}_3 \end{array}$
1050	O-H bending and C-O stretching vibrations

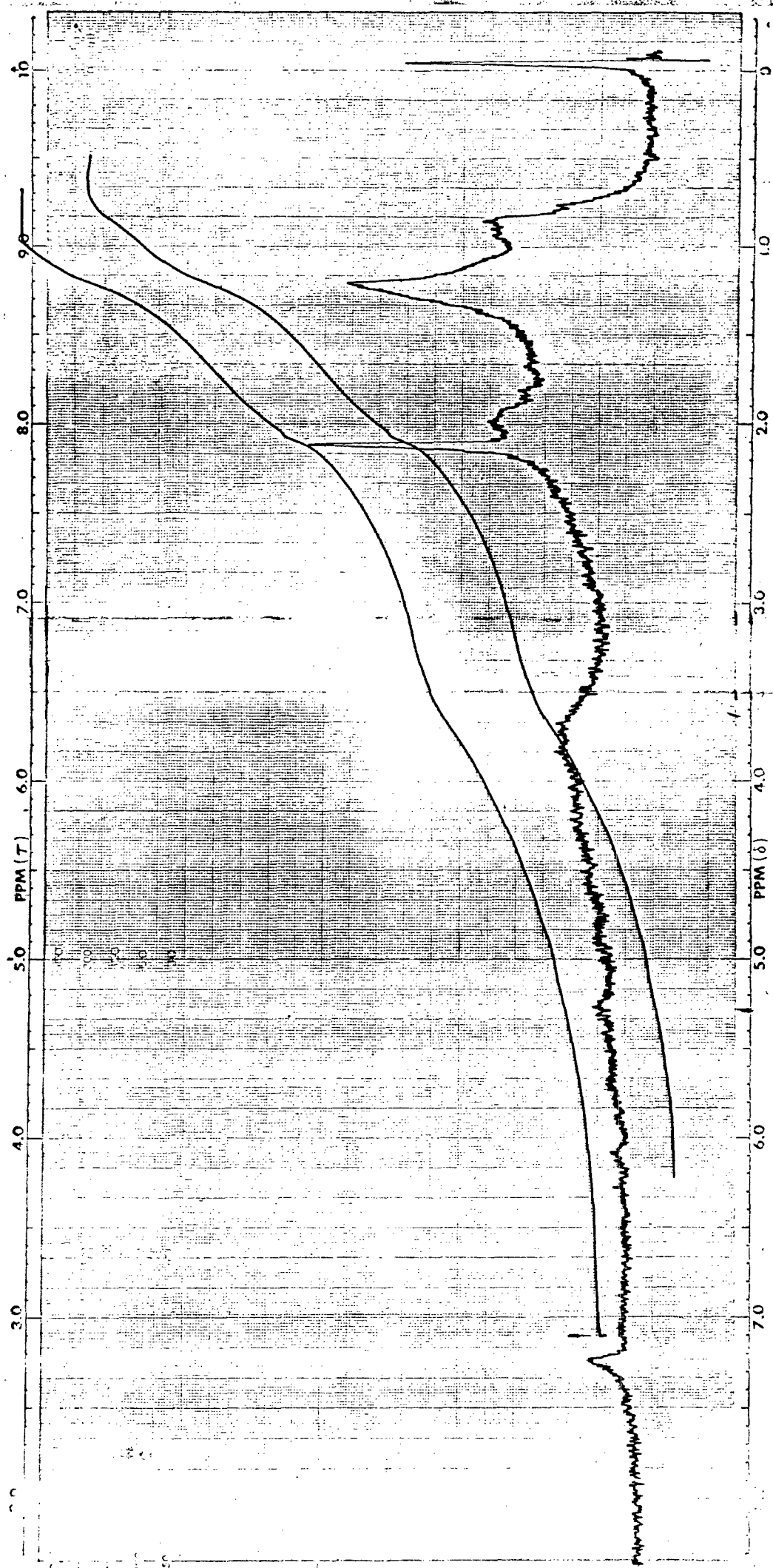
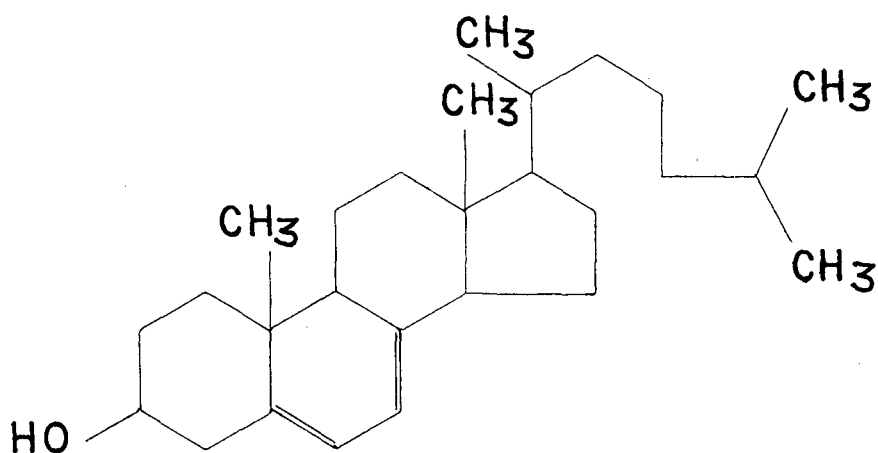


PLATE XXVII

N.M.R. Spectrum Studies

The n.m.r. spectrum of the compound (PLATE - XXVII) gave signals at δ 3.7 br., m (1 proton, C_3 -H), δ 5.3 m (C_3 -OH), δ 2.1 (C_{10} -CH₃), δ 1.2 (C_{13} -CH₃). The u.v. spectrum of the compound was found to be featureless in the range of 220 - 360 n.m., thus showing the absence of an α, β - unsaturated carbonyl chromophore.

By the above observations, and N.M.R. and I.R. Spectrum analysis, the following tentative structure can be assigned to sterol 'A'.



STEROL - 'A'

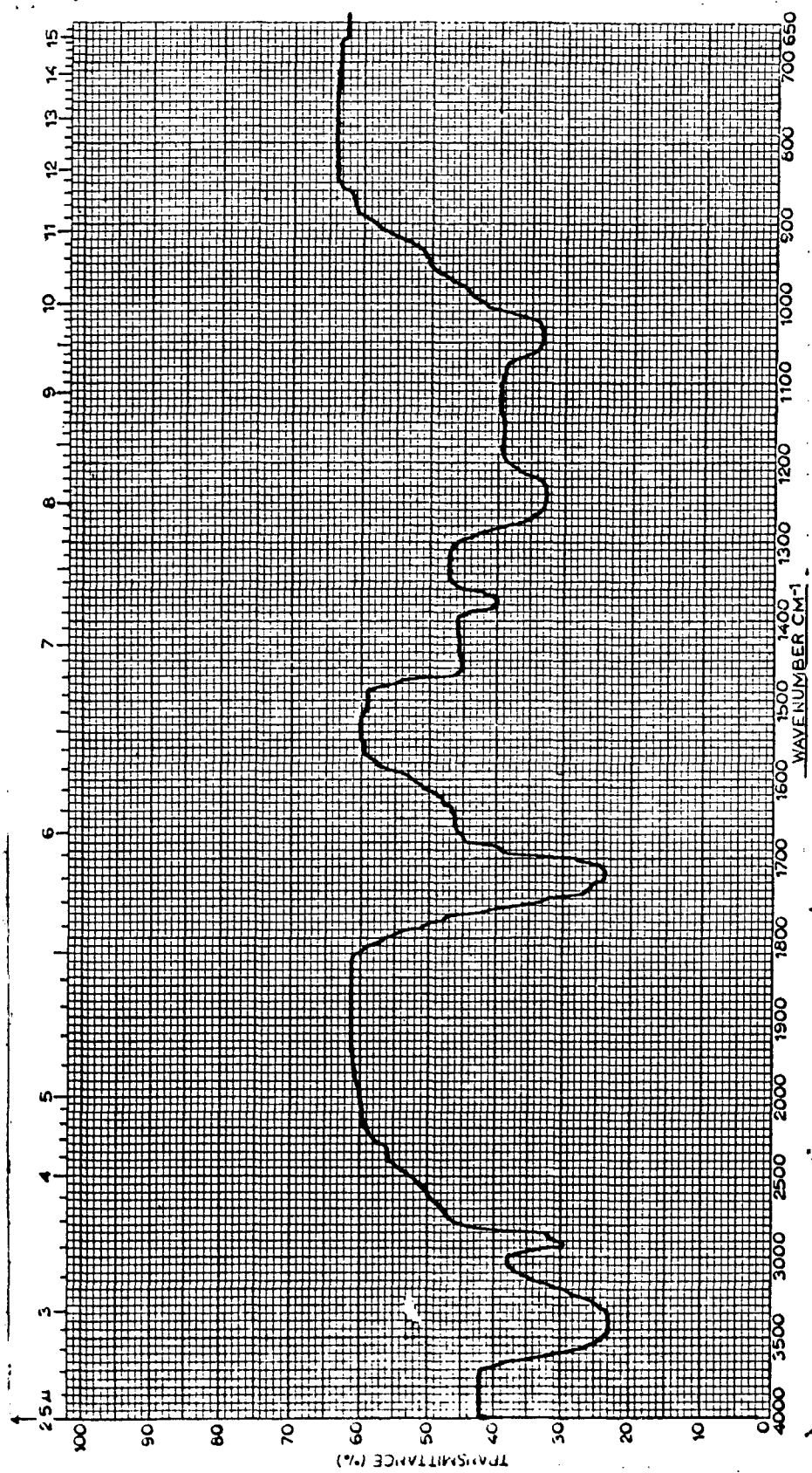
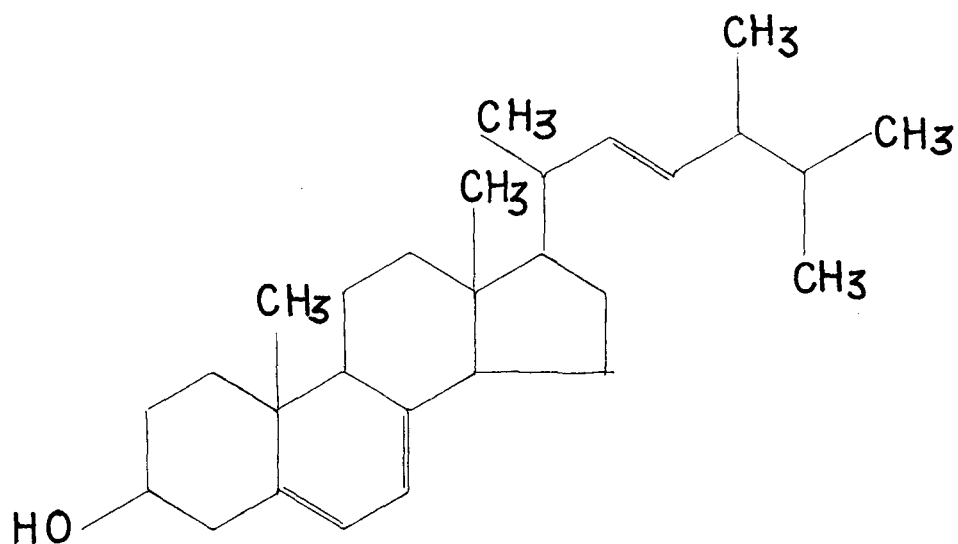


PLATE - XXVIII

The compound (m.p. 135°C) analysed correctly for $\text{C}_{28}\text{H}_{44}\text{O}$, its I.R spectrum (PLATE XXVIII) showed a strong peak at 3400 (O-H), 1050 (C-O stretching), 1380 ($-\text{H}-\text{C} \begin{smallmatrix} \text{CH}_3 \\ \text{CH}_3 \end{smallmatrix}$). The n.m.r. spectrum of the sterol gave signals at δ 3.3 br, m (1 proton, $\text{C}_3\text{-H}$), and δ 5.3 m ($\text{C}_3\text{-OH}$ and H-C=C-H), the u.v. spectrum was found to be featureless in the range 220 - 360 n.m., thus showing the absence of α,β - unsaturated carbonyl chromophore. On the basis of the observations, the compound (m.p. 135°C) has been tentatively formulated as:-



STEROL - 'B'

br., = broad

m = multiplet

S U M M A R Y

In the present study the macro and microscopical and phytochemical investigations on the bark of Bakain (Melia azedarach) have been made. The plant is a medium or moderate sized, deciduous tree having a height of 12 m. and found all over the country and planted as ornamental tree along roadsides for its flowers. The trunk of the tree is short and covered with greyish or greyish brown, vertically fissured bark, leaves form a fairly broad spreading crown bearing impari-bipinnate or occasionally tripinnate leaves. Flowers are arranged in many axillary panicles towards the end of the branches, having fragrant, liliac flowers. Fruit is a small, sub-globose drupe, half to three quarters of an inch in length. The young pieces of the bark are light brown in colour, showing alternate, wavy, tangential bands of light, dark brown coloured with lenticels. The mature bark is available in pieces of 0.2 - 1 cm. thickness, externally with rough surface, longitudinally fissured and exfoliating in small flax. They are brown to greyish brown and curved. Internal surface of both young and mature barks are brownish cream to yellowish, slightly rough and fibrous. Fracture is short in outer bark and splintery in inner bark due to its fibrous nature. There is no characteristic odour and it is slightly bitter in taste.

Transverse section of the early stage of the young stem shows single layered epidermis, covered with a thin cuticle, most of the cells of epidermis elongate to form both unicellular and branched hairs. Cortex is a wide zone of thin walled, parenchymatous cells, having some secretory cells, and nearly throughout in the cortex, rosette crystals of calcium oxalate are found present. The early stage of the young stem shows the

initiation of the pericyclic fibres. Pith is very wide, having secretory cells and few cells containing rosette crystals. Transverse section of the late stage of the young stem shows similar structure as that of the early stage. In late stage the pericyclic fibres get fully developed, and the phloem patches become prominent and differentiated with the cortical cells. The mature stem shows distinct formation of the cork, composed of 8 - 10 layers of tangentially elongated and radially arranged cells. At places in the disintegrated epidermal cells, lenticel are seen present.

Mature bark shows the formation of the rhytidoma, having alternating strips of cork tissues and secondary phloem fibre patches, which are mostly brown coloured. Phloem fibres are mostly surrounded by collapsed phloem parenchyma cells, containing few prismatic crystals of calcium oxalate and few starch grains. Some of the phloem parenchyma cells get collapsed and form the band of ceratenchyma throughout the region. In the secondary phloem region the phloem parenchyma cells contain simple starch grains. The phloem fibres are arranged in groups of alternating patches and are thick walled. Most of the ray cells contain simple starch grains and few crystals of calcium oxalate. The transverse longitudinal section (T.L.S.) of the secondary phloem region of the mature bark shows the presence of the usual elements. A few starch grains and prismatic crystals of calcium oxalate are present in the medullary rays.

The powder of the Bakain bark is reddish brown in colour, and under microscope shows both aseptate and septate phloem fibres and septate crystal fibres. Aseptate fibres are thin walled having narrow lumen and

slightly rounded tips, while the septate fibres are thick walled with wide lumen and with pointed tips. The prismatic crystals of calcium oxalate are tetra to hexagonal in shape and of varying sizes. Under ultra violet light the bark powder when treated with 1N NaOH and mounted in nitro-cellulose, exhibits a dark brown fluorescence. The total and the acid insoluble ash values of the bark are found to be 8.517% and 0.750% respectively. T.L.C. was also performed on the bark of Bakain. Under u.v. light the plate shows only two spots of blue colours with Rf. values- 0.341 and 0.780. The u.v. spectrophotometric studies of the bark revealed two prominent peaks appearing in the u.v. region, one at 288 n.m. and the other at 318 n.m.

The drug has also been subjected to large scale extraction for isolation and characterisation of sterol with the help of column chromatography and by making the Infra Red and N.M.R. Spectrum studies. Details of which has already been enumerated in the preceding paras.

CHAPTER - V

DISCUSSION & REFERENCES

D I S C U S S I O N

A. Araluka (Ailanthus excelsa)

In Ayurvedic, Unani and the Scientific literature different names are generally given to the drug Araluka viz. Mahanimba, Maharukh, Bakain and Katavanga. Even the vernacular names are also similar to certain extent given in different languages (8,9,118,31,32,33,93,94,226,199,200).

The botanical identities given to these drug yielding plants are Ailanthus excelsa and Melia azedarach. As mentioned on page 35, the drug Araluka (Ailanthus excelsa) is used in different formulations of Ayurveda with the name, Mahanimba, Maharukha, and Katavanga as mentioned above. Even these drugs have many vernacular names, and different properties are attributed to them and have various uses. These controversies and problems, not only cause difficulty in identifying the exact and authentic drug and also their wrong use and different vernacular names, lead to the wrong uses of the drug, which instead of curing the ailment may cause hazardous effects. Moreover, the drug as available in the market, did not match with the genuine specimen of the bark of Araluka collected locally and else where. Keeping in view the above facts this drug was chosen for the present study. Thus the stem bark of Araluka was investigated pharmacognostically to establish the distinguishing characters for identification purposes.

Here it may be mentioned that to trace some of the important distinguishing characters in the microscopical characters of the young and mature bark, it was felt necessary to study the young and mature stem of the drug yielding plant also. Moreover, the detailed

pharmacognostical investigation was not available, and no investigations sofar have been made prior to the present studies on the stem bark of Araluka. The salient distinguishing characters in the stem and the stem bark of Araluka are summarised in TABLE - VII.

TABLE - VII

Distinguishing characters of stem and stem bark of *Araluka* (*Ailanthus excelsa*)

Characters	Stem			Stem bark	
	Young	Mature	Young	Mature	
1	2	3	4	5	
<u>Macroscopical</u>					
Size	-	-	0.3 - 0.5 cm. thick.	1 - 2 cm. thick.	
Colour	-	-	Light yellow to grey externally.	Light grey to greyish black externally.	
Surface	-	-	Slightly rough showing leaf scars and shallow longitudinal striations. Internal surface whitish grey to yellowish grey and smooth.	Rough due to deep longitudinal fissures and transverse striations. Internal surface light yellow to creamish yellow, rough and fibrous.	
Fracture	-	-	Short in outer bark and splintery in inner bark.	Short in outer and splintery in inner bark and granular in transversely cut surface.	
Taste	-	-	No characteristic odour and taste.	Odourless and bitter in taste.	

1	2	3	4	5
<u>Microscopical</u>				
Hairs	Uni to bicellular, uniseriate with slightly rounded to pointed tips with broad base.	---- Similar.	-	-
Primary structure	Endarch vascular bundles.	Endarch vascular bundles.	-	-
Phellogen	Originate in the epidermal cells.	Originate in the epidermal cells.	Originate in the outer most layer of the cortex.	--- Similar.
Cork	3 - 4 layered.	7 - 10 layered.	Wide zone of cork.	Strips of cork.
Stone cells	Present in singles or in groups of 2 - 4 or even more with narrow to wide lumen, rounded, oval to elliptical in shape, of varying sizes.	Present singly or mostly in groups of 2 - 8, larger in size with wide lumen, shape as in young stem.	Present in singles, mostly groups of 2 - 4 in the secondary cortex, of varying size, shape and with wide lumen.	Present in between the cork strips as patches, in between the phloem fibres either singly or in groups of 2 - 3, few large in size with narrow lumen.

1	2	3	4	5
Crystals	Few rosette crystals of calcium oxalate in cortical cells.	--- Similar.	Both prismatic and rosette crystals of calcium oxalate present.	<p>--- Similar.</p> <p>Single rosette crystals of calcium oxalate present in each phloem parenchyma cell forming a crystal sheath of 3 - 12 crystals seen under T.L.S.</p>
Medullary rays	2 - 4 cells wide extending upto cortex, straight in xylem region and turned left or right in phloem region.	--- Similar.	1 - 4 cells wide, mostly straight.	1 - 9 cells wide, mostly 2 - 4 cells wide, straight.

Fluorescence characteristics

Powder as such	Cream coloured
Powder treated with 1N NaOH in methanol	Yellowish green
Powder mounted in nitro-cellulose	Greenish yellow
Powder treated with 1N NaOH in methanol and mounted in nitro-cellulose	Light green

Since the starch grains could not be seen in the macerated elements and the powder, therefore the structure of the same could not be included in the diagrams for macerated elements, powder (PLATE - VI, FIGS.9 & 10), and for the T.S. of the secondary phloem region (PLATE - V, FIG.8C). However, few of the starch grains as seen present in the secondary phloem region have been described in the text, as they have been found present only in the mature bark.

B. Katphala (Myrica nagi)

Though the fruits of the plant Katphala (Myrica nagi) are reported to be edible, but medicinally it has limited use, while the bark of Katphala, as compared to fruits have greater utility as medicine. As compared to Unani System of Medicine, the stem bark of Katphala is not used much in the Ayurvedic System. Only in one single formulation viz. Nyagrodhadi-Kvatha-Curna (8) it is used with the synonym Somavalka, to which the botanical identity Acacia catechu (called Khadir in Ayurveda) is given, as already mentioned on page 61. However, as per other references (8,9,93,31,53,83,226,201,118,74) the drug is described to be used for curing different ailments and have been attributed to possess various properties. Similarly in Unani System the bark is reported to be used for different ailments and described to possess many properties (118,83). Because of its greater use in Unani System, and its controversial nature, due to various vernacular names given in Ayurveda to this drug (8,93,31) viz. Somavalka (Acacia catechu), as already described above, has been chosen for the present study. Moreover, no detailed scientific data, especially pharmacognostical aspects, is available on the stem bark of Katphala (Kaiphala as it is called in Unani), by which its distinguishing characters could be evolved for identification purposes.

Thus in view of the above, the stem bark of Katphala (Kaiphala) has been investigated pharmacognostically to provide distinguishing characters in order to identify the genuine drug with those, if at all adulterated or substituted, as very little pharmacognostical work has been carried out

on the bark drugs particularly those which are used in Indian Systems of Medicine (I.S.M.). It is worth mentioning that stem bark of Katphala, as available both in the form of thin and thick pieces for use as medicine in the market, have been investigated in the present study. The important and salient distinguishing characters of both the forms (thin and thick) of the drug (stem bark) are given in TABLE - VIII.

TABLE - VIII

Distinguishing characters of thin and thick stem bark of Katphala (*Myrica nagi*)

Characters	Stem bark		
	Thin	Thick	
	1	2	3
<u>Macroscopical</u>			
Size	0.2 - 0.5 cm. (light in weight).	0.5 - 2.0 cm. (heavy in weight).	
Colour	Greyish brown.	Greyish brown.	
Surface	Rough externally, having numerous whitish lenticels arranged transversely with longitudinal striations, smooth and reddish brown internally, channelled and quilled.	Rough externally, having longitudinal and transverse wrinkles with whitish scars of lichens, smooth and reddish brown internally, channelled.	
Fracture	Short.	---	Similar.
Taste	Odourless and astringent.	---	Similar.

1	2	3
<u>Microscopical</u>		
Hairs	-	-
Epidermis	-	-
Phellogen	Originate in the cortical cells.	Some of the deeper cortical cells show meristematic activity and form the outer bark and cork cells.
Stone cells	A number of stone cells present in cortical cells, in singles or in groups of 2 - 3, having different shape and size, even elliptical, having radiating canals, some with concentric striations and narrow to wide lumen.	A number of stone cells present in the cortical region, in singles or in groups of 2 - 5, of varying size and shape, mostly elleptical, with narrow to wide lumen and radiating canals.
Starch grains	Simple and compound throughout the tissues, simple grains measuring 3 - 14 μ in diameter, compound consisting of 2 - 3 components.	--- Similar.

1	2	3
Crystals	Prismatic crystals of calcium oxalate present.	--- Similar.
	10 - 25 chambered crystal fibres present, each chamber having single prismatic crystals of calcium oxalate seen under T.L.S.	--- Similar.
Medullary rays	Extended upto secondary cortex, 2 - 7 cells wide and 5 - 15 cells high.	--- Similar.

Fluorescence characteristics

Powder as such	Bluish green
Powder treated with 1N NaOH in methanol	Bluish black
Powder mounted in nitro-cellulose	Bluish black
Powder treated with 1N NaOH in methanol and mounted in nitro-cellulose.	Bluish black

C. Bakain (Melia azedarach)

The drug Bakain (Melia azedarach) is basically the drug of Unani System, which later on was included in the Ayurveda System of Medicine. The medicinal properties of the various parts of the drug yielding plant viz. root bark, fruits, flowers and leaves were known to Arabs and then to Iranians, who later on brought the knowledge to India through muslim impact. Some of the important formulations of Unani System, where the leaves, seeds and the bark are used as important ingredients have already been mentioned on page 85. In Ayurveda the roots of the plant is described to possess various medicinal virtues, as already described earlier, but the stem bark of Bakain has very little use (8). Similarly various other parts are mentioned to have medicinal virtues as described in many references (already mentiond), do not find place in the Ayurvedic formulations described in the classical texts (8). Only stem bark of Bakain has been used in the formulations as mentioned on page 86, with the name Mahanimba, which is the name given to Araluka (Ailanthus excelsa). Similarly Bakain (Melia azedarach) is also named Mahanimba (Araluka), which is called Maharukh in Unani.

Because of these above enumerated cantroversies in their nomenclature and their botanical identity the drug was therefore, selected for the present study. Moreover, there is no authentic and detailed pharmacognostical work available on the stem bark of Bakain, which could throw light on its distinguishing characters, for exact identification and authentication, of the drug used in Indian System of Medicine specially in Unani System so commonly.

The salient and distinguishing macro and microscopical characters of the stem bark of Bakain are given in TABLE - IX.

TABLE - IX

Distinguishing characters of mature stem bark of

Bakain (Melia azedarach)

Characters	Mature bark
<u>Macroscopical</u>	
Size	0.2 - 1 cm.
Colour	Brownish to grey brown externally, brownish cream to yellowish internally.
Surface	Rough externally, fissures longitudinal; exfoliating and curved, internally slightly rough and fibrous, lenticels present.
Fracture	Short in outer bark and splintery in inner.
Taste	No odour and slightly bitter in taste.

Characters	Young stem			Mature bark
	Early stage	Late stage		
1	2	3		4
<u>Microscopical</u>				
Hairs	Uni-cellular to branched (stellate), uni-cellular hairs broad at base and pointed or rounded at tips; branched hairs biseriate, multicellular stalk, and long radiating unicellular hairs with pointed tips.	--- Similar.		-
Epidermis	Single layered with thin cuticle.	--- Similar.		-
Primary structure	Endarch vascular bundles.	--- Similar.		-
Phellogen	Originate in the epidermal cell.	--- Similar.		-
Cork	-	8 - 10 layered.	Alternating strips of many layered cork (inner and outer) due to the formation of Rhytidoma.	

1	2	3	4
Crystals	Rosette crystals of calcium oxalate present mostly in the cortex alongwith few secretory cells in the cortex and pith region.	--- Similar.	Prismatic crystals of calcium oxalate mostly present in the secondary phloem region. Crystal fibres present, consisting of 15 - 25 crystals of prismatic crystals of calcium oxalate in each chamber.
Starch grains	-	-	Simple starch grains present throughout the tissue of the bark, mostly in the cortical and the secondary phloem region.
Medullary rays	-	-	3 - 7 cells wide, ending at the cork strips and get narrowed between two phloem fibre patches.

Fluorescence characteristics

Powder as such	Colourless with violet tinge.
Powder treated with 1N NaOH in methanol	Greenish yellow
Powder mounted in nitro-cellulose	Light greenish yellow
Powder treated with 1N NaOH in methanol in nitro-cellulose.	Dark brown

Though the fruit, heart wood, cortex and bark of the drug Bakain is reported to contain various chemical constituents as given on page 87, but no phytochemical work has been done on Stem Bark of Bakain in detail. Therefore, the drug has been subjected to phytochemical studies in detail and the powder of the drug was extracted on large scale with different solvents, and two sterols have been isolated with the help of column chromatography from the chloroform extract. The isolated Sterols 'A' and 'B' having melting points 159°C and 135°C respectively were subjected for spectroscopic investigations (I.R., N.M.R. and U.V.). With the help of elemental analysis, preparation of digitonide derivative, I.R., U.V. and N.M.R. spectrum the tentative structures have been assigned to the sterols 'A' and 'B', given on page 113 and 114 respectively.

The three bark drugs - Araluka (Ailanthus excelsa), Katphala (Myrica nagi) and Bakain (Melia azedarach) have been worked out in detail during the course of the present investigations for macro and microscopical aspects as given above. Alongwith this the barks have also been subjected to the determination of extractive values (%age) in different solvents and chemical tests were performed for each solvent to know for the important constituents present in the drug. Microchemical tests and fluorescence analysis have also been made and tabulated separately for each drug. Ash contents and extractive values have been determined. Thin layer chromatographic (T.L.C.) and U.V. spectrophotometric studies have been made for crude extracts of all the three drugs, and described separately in the respective chapters. All these aspects have been covered

under preliminary investigations of three drugs. Due to paucity of time only the drug Bakain (Melia azedarach) has been investigated for the isolation and characterisation of the main compounds by way of large scale extraction.

Trust that the present investigation will be of great help to the research workers engaged in the study of pharmacognosy and drug identification especially on the 'Bark Drugs' used in Indian System of Medicine (I.S.M.).

REFERENCES

1. Ainslie, W., 1813, Materia Medica of Hindustan, Madras.
2. Atal, C.K., and S.S. Lamba, 1959, Indian J. Pharm., 21, 336.
3. Atal, C.K., and K.L. Khanna, 1960, J. Pharm. Pharmacol., 12, 365.
4. Atal, C.K., and K.L. Khanna, 1960, ibid., 12, 739.
5. Atal, C.K., and P.D. Sethi, 1961, Ind. J. Pharm., 23, 7.
6. Atal, C.K., S.S. Banga, and S.M.J.S. Quadry, 1962, ibid., 24, 2.
7. Atal, C.K., and S.P. Sood, ibid., 26, 197.
8. Ayurvedic Formulary of India, Part-I, 1978, First Edn., 49-91, Ministry of Health & Family Welfare, New Delhi.
9. Ayurvedic Formulary of India, Part-I, 1978, First Edn., 170, Ministry of Health & Family Welfare, New Delhi.
10. Aziz, M.A., 1961, Unani or Arab Medicine, Inst. of Hist. of Medicine and Med. Res., New Delhi.
11. Bal, S.N., 1939, Indian J. Pharm., I, 58.
12. Bal, S.N., 1940, ibid., 2, 130.
13. Bal, S.N., and S.C. Datta, 1941, ibid., 3, 55.
14. Basu, A., 1946, Indian Pharmacist, 4, 164.
15. Bhatia, N., Y. Mohan, and R.L. Khosa, 1983, Indian Drugs, 20, (6), 240.
16. Bhatia, N., M. Sahai, and R.L. Khosa, 1985, J. Ind. Chem. Soc., L XII, 75-76.
17. Bhatnagar, J.K., and M.S. Dunn, 1961, Amer. Jour. Pharm., 133 (9), 327-43.
18. Bhatnagar, J.K., and M.S. Dunn, 1962, ibid., 134, (8), 292-304.
19. Bhatnagar, J.K., and M.S. Dunn, 1962, ibid., 134, (12), 447-58.
20. Bhatnagar, J.K., and M.S. Dunn, 1963, ibid., 135, (3), 98-110.
21. Bhatnagar, J.K., and M.S. Dunn, 1963, ibid., 135, (8), 288-306.

22. Boissier, E., 1818, Flora Orientalis, 4 Vols. and Supplts.
23. Bose, K.C., 1932, Pharmacopoeia Indica, Calcutta, 178.
24. Chase, C.R., and Pratt, 1949, J. Amer. Pharm. Assoc., Sec. Edn., 38, 324.
25. Chatelier du, G.G., 1948, Ann. Pharm. Franc., 6, 507.
26. Chatterji, R., and J.K. Lahiri, 1949, J. Amer. Pharm. Assoc., Sci. Edn., 38, 11.
27. Chopra, I.C., 1947, Indian J. Agri. Sci., 16, 444.
28. Chopra, I.C., K.L. Handa, and L.D. Kapoor, 1960, Medicinal Plants of Arid Zones, UNESCO.
29. Chopra, R.N., 1933, Indigenous Drugs of India, Art Press, Calcutta.
30. Chopra, R.N., and I.C. Chopra, 1955, Review of Work on Indian Medicinal Plants, I.C.M.R., New Delhi.
31. Chopra, R.N., I.C. Chopra, and S.L. Nayar, 1956, Glossary of Indian Medicinal Plants, C.S.I.R., New Delhi.
32. Chopra, R.N., S.L. Nayar, and I.C. Chopra, 1956, Glossary of Indian Medicinal Plants, 9-10, C.S.I.R., New Delhi.
33. Chopra, R.N., S.L. Nayar, and I.C. Chopra, 1956, Glossary of Indian Medicinal Plants, 163-164, C.S.I.R., New Delhi.
34. Chopra, R.N., S.L. Nayar, and I.C. Chopra, 1956, ibid., 172, C.S.I.R., New Delhi.
35. Chopra, R.N., I.C. Chopra, and B.S. Verma, 1980, ibid., Suppl., C.S.I.R., New Delhi.
36. Chopra, R.N., and I.C. Chopra, K.L. Handa and L.D. Kapoor, 1958, Chopra's Indigenous Drugs of India, Sec. Edn., U.N. Dhur & Sons Pvt. Ltd., Calcutta.
37. Chopra, R.N., I.C. Chopra, and L.D. Kapoor, 1958, Insecticidal and Pesticidal Plants of India.
38. Chopra, R.N., S.L. Bhadwar, and S. Ghosal, 1958, Poisonous Plants of India.

39. Chopra, R.N., 1960, Indian J. Pharm., 23.
40. Corfield, C.E., et. al., 1943, Quart. J. Pharm. Pharmacol., 16, 108.
41. Datta, S.C., 1944, Indian J. Pharm., 6, 141.
42. Datta, S.C., and S.N. Bal, 1945, ibid., 7.
43. Datta, S.C., B. Gupta, and S.N. Bal, 1945, Indian Pharmacist, 1, 6.
44. Datta, S.C., 1946, Science and Culture, 12, 246.
45. Datta, S.C., 1949, Indian Pharmacist, 4, 290.
46. Datta, S.C., and B. Mukerji, 1950, Pharmacognosy of Indian Roots and Rhizome Drugs, Govt. of India Press, Calcutta.
47. Datta, S.C., and B. Mukerji, 1955, Pharmacognosy of Leaf Drugs, Govt. of India Press, Calcutta.
48. Datta, S.C., B. Mukerji, and D. Datta, 1961, J. Sci. Industr. Res., 20C, 1.
49. Datta, S.C., 1961, Indian J. Pharm., 23, 241.
50. Dennis, T.J., T.G. Joseph, K.P. Mishra, and G.K. Bhatt, 1976, Jour. Res. Indian Med. Yoga and Homoeo., 11 (3), 61-63.
51. Dewar, T., 1933, Quart. J. Pharm. Pharmacol., 6, 443.
52. Dewar, T., 1934, ibid., 7, 1.
53. Day, K.L., 1896, Indigenous Drugs of India, Thacker, Spinks & Co., Calcutta.
54. Duthie, J.F., 1960, Flora of the Upper Gangetic Plain and of the Adjacent Siwalik and Sub-Himalayan Tracts, 2 Vols., Botanical Survey of India, Calcutta.
55. Dutt, U.C., 1877, Materia Medica of the Hindus, Calcutta.
56. Dymock, W., 1883, Vegetable Materia Medica of Western India, Bombay.
57. Dymock, W., C.J.H. Warden, and D. Hooper, 1889 - 93, Pharmacographia Indica, 3 Vols., London.
58. Fairbairn, J.W., 1945, Y.B. Pharm., 207.

59. Feldman, H.S., and H.W. Youngken, 1944, J. Amer. Pharm. Assoc., Sci. Edn., 33, 277.
60. Fleming, J., 1810, Catalogue of Indian Medicinal Plants and Drugs, Calcutta.
61. Flueckiger, F.A., and D. Hanbury, 1879, Pharmacographia, Sec. Edn., Macmillan and Company, London.
62. Forsdike, J.L., and H.O. Meek, 1946, Quart. J. Pharm. Pharmacol., 19, 340.
63. Forsdike, J.L., 1949, J. Pharm. Pharmacol., 1, 34.
64. Forsdike, J.L., and B. Jhonson, 1949, J. Pharm. Pharmacol., 1, 661.
65. Gaind, K.N., and S.K. Baveja, 1960, J. Amer. Pharm. Assoc., Sci. Edn., 49, 659.
66. Greenish, H.G., 1895, Pharm. J., 54, 685.
67. Greenish, H.G., 1896, ibid., 55, 413.
68. Greenish, H.G., 1919, Foods and Drugs, London.
69. Greenish, H.G., 1920, Pharm. J., Sept. 18, 284.
70. Greenish, H.G., 1933, Text Book of Pharmacognosy.
71. Holmes, E.M., 1923, Pharm. J., 57, 634.
72. Hooker, J.D., 1872 - 97, The Flora of British India, 7 Vols., L. Reeve and Co., London.
73. Irvine, R.H., 1847, Materia Medica of Patna.
74. Iyer, K.N., et. al., 1957, Pharmacognosy of Ayurvedic Drugs, 1 (3), 39-41, Trivendrum, Kerala.
75. Iyer, K.N., et. al., 1957, ibid., 1 (4), Trivendrum, Kerala.
76. Iyer, K.N., et. al., 1960, ibid., Trivendrum, Kerala.
77. Jackson, B.P., and J.M. Rowson, 1953, J. Pharm. Pharmacol., 5, 778.
78. Jackson, B.P., and T.E. Wallis, 1955, ibid., 7, 384.
79. Jain, M.K., 1963, Indian J. Chem., 2 (1), 40.

80. Jain, M.K., 1964, ibid., 2 (1), 40.
81. Johansen, D.A., 1940, Plant Microtechnique, McGraw-Hill Book Co., Inc., New York, 182.
82. Jones, Sir William, 1799, Botanical Observations on Selected Indian Medicinal Plants, London.
83. Kabiruddin, M., 1929, Kitab-ul-Adviyah (Urdu), Vol.II, Daftar-ul-Masih, Hyderabad.
84. Kabiruddin, M., 1950, Tarjuma-i-Kabir, Vol.I - IV, Daftar-ul-Masih, Hyderabad.
85. Kapoor, S.K., P.I. Ahmad, and A. Zaman, 1971, Phytochemistry, 10 (12), 3333.
86. Karandikar, G.K., 1959, Indian. J. Pharm., 21, 200.
87. Karandikar, G.K., 1959, ibid., 21, 204.
88. Karandikar, G.K., 1959, ibid., 21, 327.
89. Kay, A.L., 1938, The Microscopical Study of Drugs, Balliere, Tindal and Cox., London - 16.
90. Khan, A.H., 1944, Indian Forester, 106.
91. Khan S.A., S.S. Zuberi, and K.M. Shamsuddin, 1980, Indian J. Chem., 19B, 183-184.
92. Khan, S.A., and K.M. Shamsuddin, 1978, Indian J. Chem., 16B (11), 1045-1046.
93. Kirtikar, K.R., and B.D. Basu, 1933, Indian Medicinal Plants, 4 Vols., L.M. Basu, Allahabad.
94. Kirtikar, K.R., and B.D. Basu, 1935, Indian Medicinal Plants, Sec. Edn., Vol.I, 505-506, Periodical Experts, Delhi.
95. Krishnamoorthy, V., N.R. Krishnaswamy, and T.R.Seshadri, 1963, Current Science, 32 (1), 16.
96. Krishnamoorthy, V., and T.R. Seshadri, 1971, Indian J. Chem., 9 (4), 379.
97. Krishnaswamy, R., and J.C. David, 1940, Indian J. Pharm., 2, 141.

98. Kulkarni, J.D., J.M. Rowson, and G.E. Trease, 1955, J. Pharm. Pharmacol., 7, 905.
99. Kulkarni, J.D., J.M. Rowson, and G.E. Trease, 1955, ibid., 7, 914.
100. Kulkarni, J.D., J.M. Rowson, and G.E. Trease, 1956, ibid., 8, 937.
101. Kulkarni, J.D., J.M. Rowson, and G.E. Trease, 1957, ibid., 9, 763.
102. Kulkarni, J.D., J.M. Rowson and G.E. Trease, 1958, ibid., 10, 112.
103. Kurz, S., 1877, Forest Flora of British Burma, Calcutta.
104. Kutumbiah, P., 1962, Ancient Indian Medicine, Orient Longmans, New Delhi.
105. Mehra, P.N., 1939, Ferns of Mussorie, Punjab University Publication, Lahore.
106. Mehra, P.N., and J.K. Bhatnagar, 1958, Indian J. Pharm., 20, 33.
107. Mehra P.N., and L.C. Garg, 1962, Proc. Ind. Pharm. Cong.
108. Mehra, P.N., and S.S. Jolly, 1961, ibid.
109. Mehra, P.N., and T.N. Khoshoo, 1951, J. Pharm. Pharmacol., 3, 486.
110. Mehta, C.R., and C.N. Patel, 1959, Indian J. Pharm., Part I, 21 (5), 143-145.
111. Melville, C., 1944, Quart. J. Pharm. Pharmacol., 17, 213.
112. Melville, C., 1945, ibid., 18, 331.
113. Melville, C., 1949, J. Pharm. Pharmacol., 1, 156.
114. Mittal, T.C., and P.N. Mehra, 1960, J. Pharm. Pharmacol., 12, 317.
115. Mittal, T.C., 1961, Indian J. Pharm., 23, 55.
116. Mukerji, B., 1945, Indian Pharmacist, 1, 31.
117. Musick, A.H., and H.W. Youngken Jr., 1943, Amer. J. Pharm., 12, 449.
118. National Formulary of Unani Medicine, Part I, 1983, First Edn., Ministry of Health and Family Welfare, New Delhi.
119. Nayar, R.C., A.H. Zaidi, and S.B. Vohra, 1979, XXXI, Indian Pharmaceutical Congress.

120. Nayar, S.L., and B.S. Bisht, 1958, J. Sci. Industr. Res., 17C, 162.
121. Nayar, S.L., and C.L. Madan, 1959, ibid., 18C, 10.
122. Nayar, S.L., 1959, ibid., 18C, 224.
123. Nayar, S.L., 1959, ibid., 18C, 253.
124. O' Shaughnessy, Sir Williams, 1844, Bengal Pharmacopoeia.
125. Prasad, S., 1940, Indian J. Pharm., 2, 36.
126. Prasad, S., 1941, ibid., 3, 62.
127. Prasad, S., 1941, ibid., 3, 114.
128. Prasad, S., 1943, ibid., 5, 65.
129. Prasad, S., 1944, ibid., 6, 13.
130. Prasad, S., 1944, ibid., 6, 61.
131. Prasad, S., 1945, ibid., 7, 81.
132. Prasad, S., 1946, J. Amer. Pharm. Assoc., Sci. Edn., 35, 121.
133. Prasad, S., 1947, ibid., 36, 180.
134. Prasad, S., 1947, ibid., 36, 343.
135. Prasad, S., 1948, ibid., 37, 346.
136. Prasad, S., 1948, ibid., 37, 103.
137. Prasad, S., 1949, Indian J. Pharm., 12, 200.
138. Prasad, S., 1950, Indian J. Pharm., 13, 200.
139. Prasad, S., 1954, Indian Pharmacist, 9, 375.
140. Prasad, S., and P.N. Kaul, 1956, Indian J. Pharm., 18, 423.
141. Prasad, S., and K.C. Gupta, 1957, ibid., 19, 163.
142. Prasad, S., and M.M. Vohra, 1958, ibid., 20, 285.
143. Prasad, S., and S.P. Luthra, 1959, ibid., 21, 189.

144. Prasad, S., and M.M. Vohra, 1960, J. Sci. Industr. Res., 19C, 54.
145. Prasad, S., P.K. Gupta, and I.C. Bhattacharya, 1960, ibid., 19C, 92.
146. Prasad, S., K.C. Nayar, and I.C. Bhattacharya, 1960, ibid., 19C, 119.
147. Prasad, S., and K.C. Nayar, 1960, ibid., 19C, 139.
148. Prasad, S., S.P. Wahi, and A.K. Taneja, 1961, J. Sci. Industr. Res., 20C, 92.
149. Prasad, S., P.N. Natrajan, and S.P. Wahi, 1961, ibid., 20C, 125.
150. Prasad, S., and I.C. Bhattacharya, 1961, ibid., 20C, 246.
151. Prasad, S., and S.P. Wahi, 1962 - 63, J. Sci. Res. (B.H.U.), XIII, (1), 171.
152. Prasad, S., and S.P. Wahi, 1965, Indian J. Pharm., 27, 35.
153. Prasad, S., R.L. Khosa, A.K. Wahi, and R.C. Bharadwaj, 1967, Jour. Res. Ind. Med., 1 (2), 223.
154. Prasad, S., and M.S. Ansari, 1967, ibid., 2 (1), 16.
155. Prasad, S., R. Mitra, and M.S. Ansari, 1968, ibid., 2 (2), 208.
156. Prasad, S., R. Mitra, and M.S. Ansari, 1968, ibid., 2 (2), 222.
157. Quazilbash, N.A., 1942, Qurt. J. Pharm. Pharmacol., 15, 323.
158. Quazilbash, N.A., 1943, Indian J. Pharm., 5, 161.
159. Quazilbash, N.A., 1948, Quart. J. Pharm. Pharmacol., 21, 320.
160. Quazilbash, N.A., 1949, Pharm. J., Aug. 6, 108.
161. Ramstad, E., 1959, Modern Pharmacognosy, Wiley Publication.
162. Ray, Sir P.C., 1902, 1909, History of Hindu Chemistry, Vol.I & II, Calcutta.
163. Razzack, Hkm. M.A., and U. Fazal, 1977, Report on Arab Medicine and the State of Kuwait, New Delhi.
164. Ridgway, R.M., and J.M. Rowson, 1956, J. Pharm. Pharmacol., 8, 915.
165. Rohatgi, S., and J.W. Fairbairn, 1950, ibid., 2, 286.

166. Rohatgi, S., 1951, ibid., 3, 557.
167. Rowson, J.M., 1950, ibid., 2, 201.
168. Rowson, J.M., 1960, ibid., 12, 66 T.
169. Rowson, J.M., 1960, ibid., 12, 88 T.
170. Roxburgh, W., 1832, Flora Indica, 3 Vols., Calcutta.
171. Royle, J.F., 1837, An Essay on the Antiquity of Hindu Medicine, London.
172. Saber, A.H., 1934, Y. B. Pharm., 645.
173. Santra, D.K., 1960, Indian J. Pharm., 22, 11.
174. Satakopan, S.K., P.J. Thomas, 1970, Indian J. Pharm., 32 (3), 66-67.
175. Shah, C.S., and B.C. Mehta, 1956, ibid., 18, 84.
176. Shah, C.S., L.S. Vyas, and L.P. Aghara, 1957, ibid., 19, 10.
177. Shah, C.S., V.M. Sukkawala, and L.S. Vyas, 1959, ibid., 21, 195.
178. Shah, C.S., and M.K. Pandhe, 1960, ibid., 22, 66.
179. Shah, C.S., R.S. Medora, and G.C. Bhavsar, 1960, ibid., 22, 284.
180. Shah, C.S., R.S. Medora, and G.C. Bhavsar, 1961, ibid., 23, 192.
181. Shah, C.S., and P.N. Khanna, 1963, ibid., 25, 370.
182. Shah, C.S., R.P. Patel, P.N. Khanna, and T.P. Gandhi, 1964, ibid., 26, 168.
183. Shah, C.S., and N.S. Shah, 1966, ibid., 28, 103.
184. Shah, C.S., and J.S. Qadry, 1971, Text Book of Pharmacognosy, First Edn., Messers B.S. Shah, Ahmedabad.
185. Sharma, P.V., 1981, Ayurved ka Vaigyanik Itihas, Sec. Edn., Chavkhamba Orientalia, Varanasi.
186. Short, G.R.A., 1925, Pharm. J., 115, 156.
187. Singh, A.K., 1988, Bull. of Medico-Ethno-Botanical Res., IX, (1-2), 68-77.

188. Singh, B.N., 1939, Indian J. Pharm., 1, 199.
189. Sirkar, N.N., 1943, ibid., 5, 114.
190. Sirkar, N.N., 1944, ibid., 6, 9.
191. Skyrone, E.W., and T.E. Wallis, 1936, Quart. J. Pharm. Pharmacol., 9, 198.
192. Skyrone, E.W., 1935, ibid., 8, 1.
193. Skyrone, E.W., 1935, ibid., 8, 161.
194. Small, J., 1919, Y. B. Pharm., 413.
195. Small, J., 1928, ibid., 163.
196. Soos, E., et. al., 1950, Sci. Pharmaceut., 18, 135.
197. Steineggar, E., 1944, Pharm. Acta. Helv., 19, 167.
198. Strachey, R., 1852, Catalogue of the Plants of Kumaon, Garhwal and Tibet, revised by J.F. Duthie, 1874.
199. The Wealth of India (Raw Materials), 1948, Vol.I, 41, C.S.I.R., New Delhi.
200. The Wealth of India (Raw Materials), 1949, 7 Vols., 63, C.S.I.R., New Delhi.
201. The Wealth of India (Raw Materials), 1969, Vol.I - IX, C.S.I.R., New Delhi.
202. Trease, G.E., and W.C. Evans, 1954, Pharm. J., 144, 351.
203. Trease, G.E., and J.D. Kulkarni, 1955, J. Pharm. Pharmacol., 7, 463.
204. Trease, G.E., 1961, A Text Book of Pharmacognosy, Eighth Edn.
205. Trease, G.E., 1966, A Text Book of Pharmacognosy, Ninth Edn., Balliere, Tindal and Cassel Ltd., London.
206. Wahid, A., and H.H. Siddiqui, 1961, Survey of Drugs, Inst. of Hist. Med. and Medical Res., Hamdard Buildings, Delhi.
207. Wallich, N., 1836, Trans of Med. and Phys. Soc. of Calcutta, 8.
208. Wallis, T.E., 1901, Pharm. J., 67, 552.

209. Wallis, T.E., 1921, ibid., 87.
210. Wallis, T.E., 1931, ibid., 4, 28.
211. Wallis, T.E., and S. Goldberg, 1937, Quart. J. Pharm. Pharmacol., 10, 311.
212. Wallis T.E., 1942 - 43, Proc. of Linnean Soc., Session 155, Pt.3, 9th June, 1944, 229.
213. Wallis, T.E., and P.K. Sanyal, 1947, Quart. J. Pharm. Pharmacol., 20, 272.
214. Wallis, T.E., and D.K. Santra, 1947, ibid., 20, 291.
215. Wallis, T.E., 1948, ibid., 21, 333.
216. Wallis T.E., 1948, ibid., 21, 35.
217. Wallis, T.E., 1948, ibid., 21, 321.
218. Wallis, T.E., and S. Rohatgi, 1949, J. Pharm. Pharmacol., 1, 292.
219. Wallis T.E., 1952, ibid., 4, 243, 471.
220. Wallis, T.E., 1960, Text Book of Pharmacognosy, Fourth Edn., J. & A. Churchill Ltd., London.
221. Waring, J.J., 1868, Pharmacopoeia of India, London.
222. Wasti, S.A.A.N., 1937, Tibb-ul-Arab, Part I, 4 (2), 11-85.
223. Wasti, S.A.A.N., 1938, ibid., Part III, 5 (4), 9-78.
224. Wasti, S.A.A.N., 1948, ibid., Special No.7 (9), 8-97.
225. Watt, G., 1889 - 93, A Dictionary of the Economic Products of India, 6 Vols., W.H. Allen & Co., London.
226. Watt, G., 1972, ibid., I - IX, Sec. Reprint, Cosmo Publication, Delhi.
227. Wight, R., 1838 - 58, Icones Plantarum Indae Orientalis, Madras.
228. Wise, A., 1845, Commentory of the Hindu System of Medicine, Calcutta.
229. Youngken, H.W. Sr., 1944, J. Amer. Pharm. Assoc., Sci. Edn., 33, 145.
230. Youngken, H.W. Sr., 1946, ibid., Sci. Edn. 35, 148.
231. Youngken, H.W. Sr., 1954, ibid., 43, 141.

- 232. Youngken, H.W. Sr., 1954, ibid., 43, 70.
- 233. Youngken, H.W. Sr., 1954, ibid., 43, 139.
- 234. Youngken, H.W. Sr., 1954, ibid., 43, 141.
- 235. Youngken, H.W. Sr., 1956, ibid., 45, 721.
- 236. Youngken, H.W. Sr., 1958, ibid., 47, 162.
- 237. Youngken, H.W. Sr., 1960, ibid., 49, 271.
- 238. Youngken, H.W. Sr., and M. Contoria, 1955, Amer. J. Pharm., 127, 270.
- 239. Youngken, H.W. Sr., R.E. Woodson, et. al., 1957, Rouvolfia.
- 240. Youngken, H.W. Sr., and M.L. Berman, 1954, J. Amer. Pharm. Assoc., Sci. Edn., 43, 200.
- 241. Youngken, H.W. Jr., J.W. Fairbairn, and M.C. Andries, 1956, J. Amer. Pharm. Assoc., Sci. Edn., 45, 70.
- 242. Youngken, H.W. Jr., and L.A. Sciuchetti, 1958, ibid., 47, 803.
- 243. Youngken, H.W. Jr., and W.T. Gloor, 1958, ibid., 47, 22.
- 244. Youngken, H.W. Jr., and W.T. Gloor, 1958, ibid., 47, 21.
- 245. Youngken, H.W. Jr., and M.L. Berman, 1958, ibid., 47, 888.
- 246. Youngken, H.W. Jr., and E.W. Underhill, 1962, J. Pharm. Sc., 51, 121.
- 247. Youngken, H.W. Jr., and R. Pratt, 1956, Pharmacognosy, J.B. Lippincot & Co., Montreal.